Concrete

Vol. 34 Chicago, April, 1929 No. 4

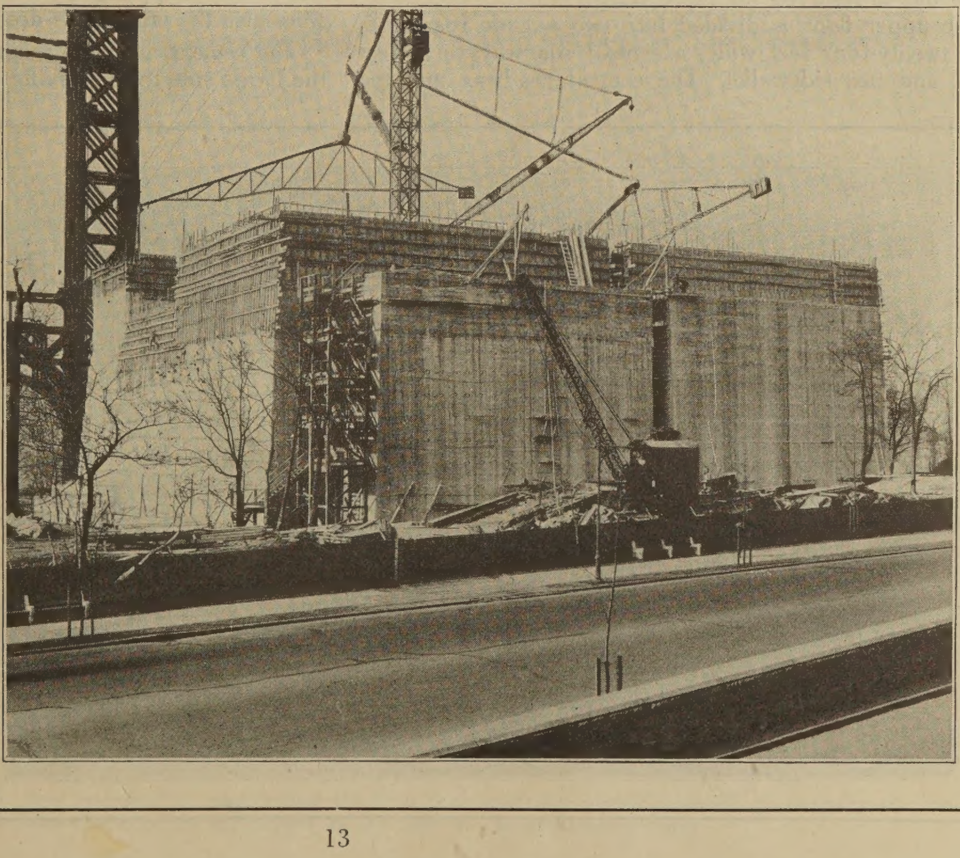
Placing 110,000 Cu. Yards of Quality Controlled Concrete *for the* *New York Anchorage of Hudson River Bridge*

By A. W. MUNSELL
Engineer of Masonry Inspection, Bridge Department
The Port of New York Authority, New York City

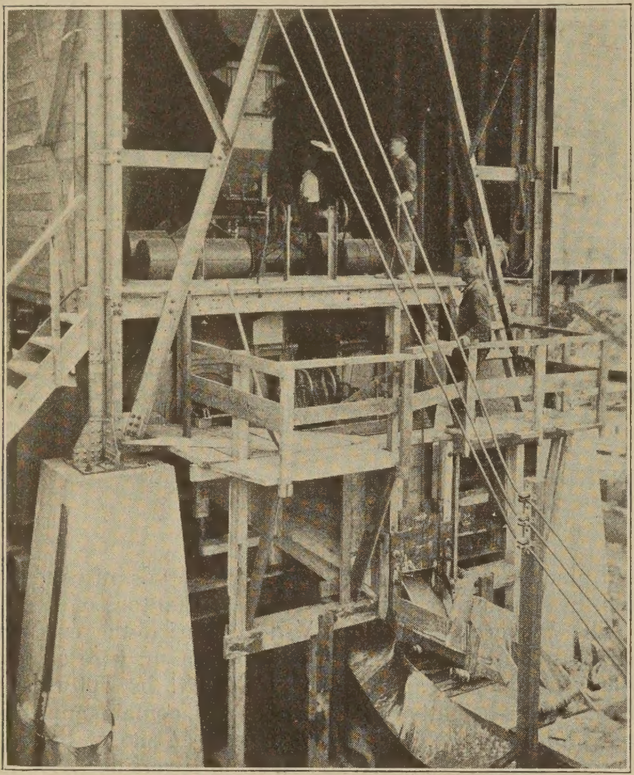
THE storage of aggregates and the mixing and placing of the concrete for the New York anchorage of the new Hudson River bridge, now under construction, presented several unique problems, aside from the large mass of concrete involved. The concrete plant designed for this job embodies some unusually interesting features, especially in the methods of conveying aggregates and concrete.

The construction of the bridge will require the making and placing of approximately 450,000 cu. yds. of concrete and the fabrication and erection of 130,000 tons of steel.

The anchorage, in which will be buried the eye bar chains to sustain the pull of the four 36-in. wire cables, 4800 ft. long, is approximately 200 ft. by 300 ft. in area with a height of 125 ft. and will contain approximately 110,000 cu. yds. of concrete. The site of the anchorage is approximately 100 ft. from Riverside Drive in Fort Washington Park, New York City.



The New York anchorage for the Hudson River bridge as it appears under construction. Riverside Drive is in the foreground



A close-up of the mixing plant

The Hudson River bridge, of which this anchorage is a portion, is of the suspension type, with a main span of 3500 ft. between centers of towers. The bridge deck will be suspended from four 36-in. wire cables, supported on steel towers 635 ft. above water level. The floor structure is arranged with two decks, of which the upper one is to serve vehicular and pedestrian traffic exclusively, and the lower one is reserved for rapid transit traffic.

The upper floor is divided into two outside roadways, each twenty-four feet wide, a central roadway forty feet wide, and two sidewalks. The central roadway and the footwalks are to constitute the initial capacity of the bridge. The central roadway will accommodate four lanes of traffic of the heaviest type. Each of the outside roadways will conveniently accommodate two lanes, and in an emergency, or intermittently, three passenger cars side by side.

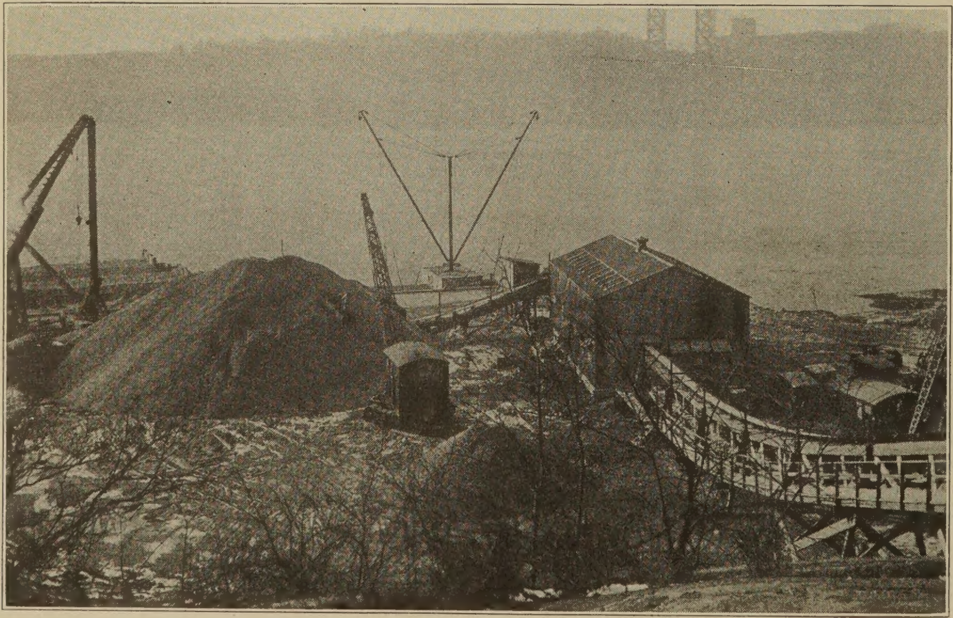
The lower deck, which is to be omitted at first and erected after the opening of the bridge for initial capacity, has been studied for four, six, and eight rapid transit tracks.

Aggregates Received in Barges

The storage piles of aggregates and the shed for cement were located at the water's edge, approximately 800 ft. from and 120 ft. lower than the site of the anchorage, and across the cut of a branch of the New York Central Railroad, approximately 250 ft. wide. The roughness of the topography required the building of a wooden trestle in some places 60 ft. high and a suspension bridge, supported on 1-in. wire cables, across the cut of the New York Central Railroad, to bring the aggregates and cement to the mixing plant.

Aggregates and cement are received in barges at the dock, where the aggregates are unloaded with steam operated stiff leg derricks, using clamshell buckets which dump on a tunnel. In the tunnel, a 26-in. belt, operating at a speed of 375 ft. per minute, receives either coarse or fine aggregates from segmental gates, opened in a fixed position for the proper amount of material without spilling. This conveyor empties onto another belt of the same width at right angles to the first, rising at an angle of approximately 16 deg., which discharges on a third belt of the same width, just west of the suspended span over the New York Central right of way, which in turn carries it to the 300 ton Blaw-Knox steel bins over the batchers. These two belt operate at a speed of 400 ft. per minute and have a capacity of 300 ton per hour. The belts are operated over troughing idlers, are equipped with screw take-ups, and are belt driven by 440 volt electric motors. They were supplied by the Manhattan Rubber Co., as were also the other belts described later.

The cement, in bags, is unloaded by ship's tackle from the barge side to the mixing plant on one continuous belt,



Showing the stockpile and the cement shed at the river's edge

20 in. wide, operating at a speed of 90 ft. per minute and having a capacity of 50 tons per hour. Most of the cement is conveyed to the mixing plant, but surplus storage is provided in a shed at the dock.

The Mixing Plant

The mixing plant, equipped with two Koehring 28-S mixers, operated by electric motors, are served with one 6000 lb. capacity Blaw-Knox weighing batcher, dumping alternately in hoppers behind each mixer.

Cement is introduced in the hoppers behind the mixers, in a 12-in. diameter pipe, with a flared upper end and a flapper valve at the bottom, which is filled with the proper number of bags per batch, emptied into the pipe from the cement storage deck about 12 feet above the mixing deck.

Koehring closed water measuring tanks, equipped with two air release valves and calibrated to half gallons, supply the mixing water for each mixer.

Each mixer is equipped with a timing device of the escapement type, which automatically locks the discharge chute and fixes the duration of the mix to 1½ minutes.

Placing the Concrete

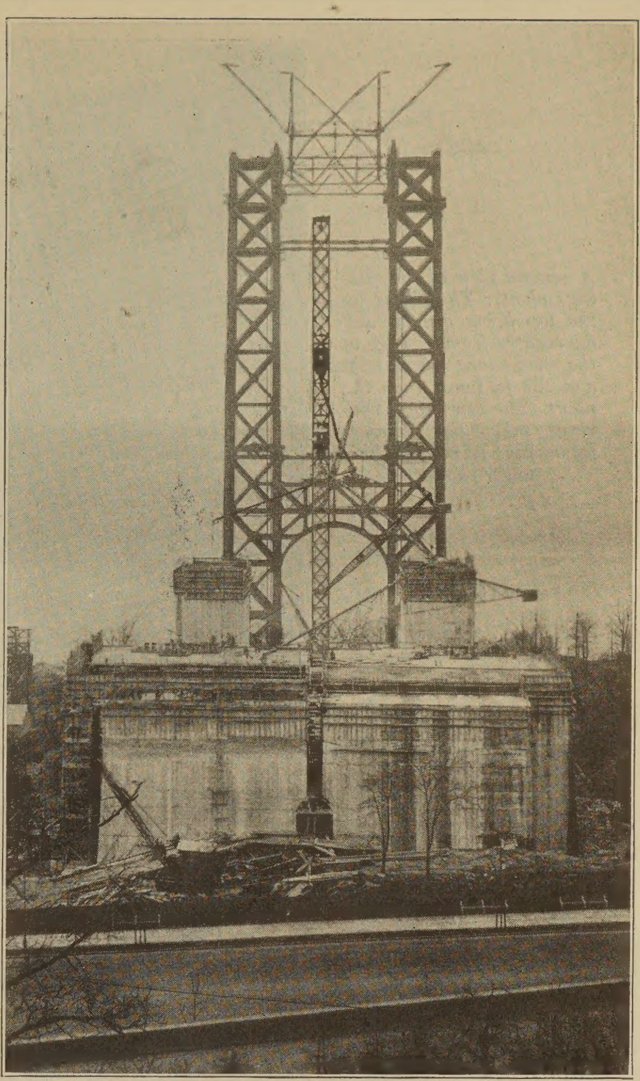
The mixers discharge into a hopper of 3 cu. yds. capacity, which feeds onto a 22-in. belt approximately 150 ft. long, operating at a speed of 550 ft. per minute, with a capacity of 150 tons per hour. This belt discharges into a 2-yd. hopper at the foot of a 260-ft. high Insley tower, placed in the center of the anchorage space, equipped with a 36-cu. ft. reversible bucket and two 75-ft. booms and 75-ft. counterweights, placed on opposite sides of the tower on sliding frames. This equipment gives complete coverage of the anchorage.

The hoppers at the mixer and the hopper which discharges into the hoisting bucket were made at the job, and are of ample size for the purpose of giving continuous operation for mixing and placing plants, even though one or the other might be stopped for several minutes.

The tower hoist is made by the Clyde Machinery Co., and is operated by a 100 h.p. electric motor, giving a line speed of 380 ft. per minute, which can be increased to 425 ft. per minute by lagging the drum.

All motors are built for continuous duty and will start under full load. This applies to those on the belts, as well as on the hoist and mixers.

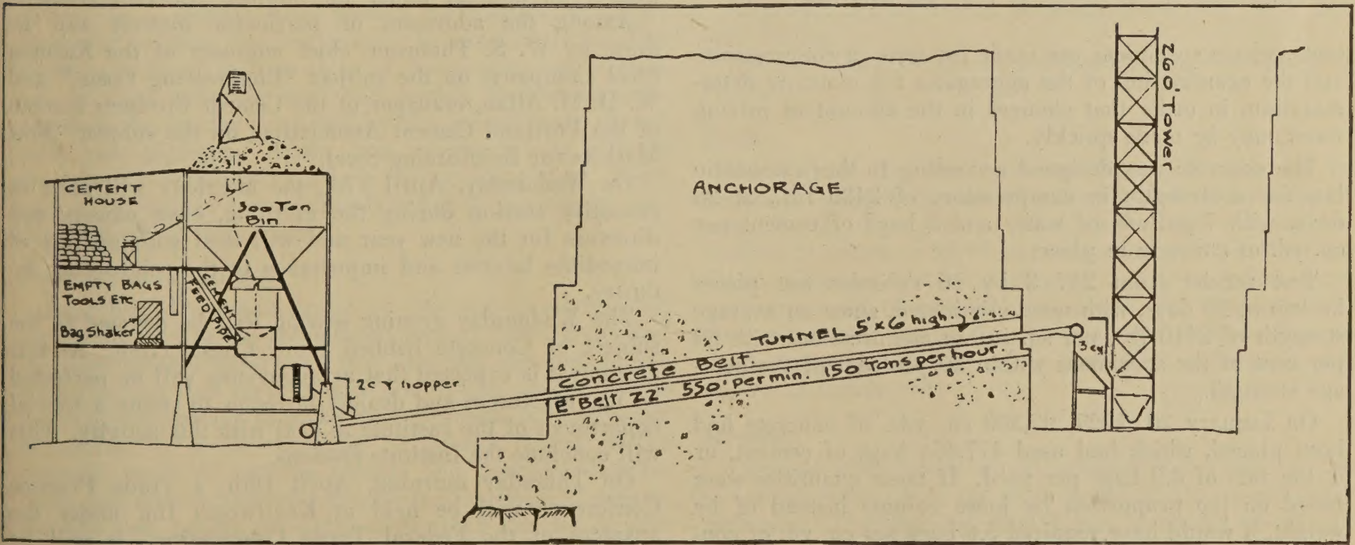
This plant has mixed and placed as high as 1600 cu. yds. per 20 hours in two shifts.



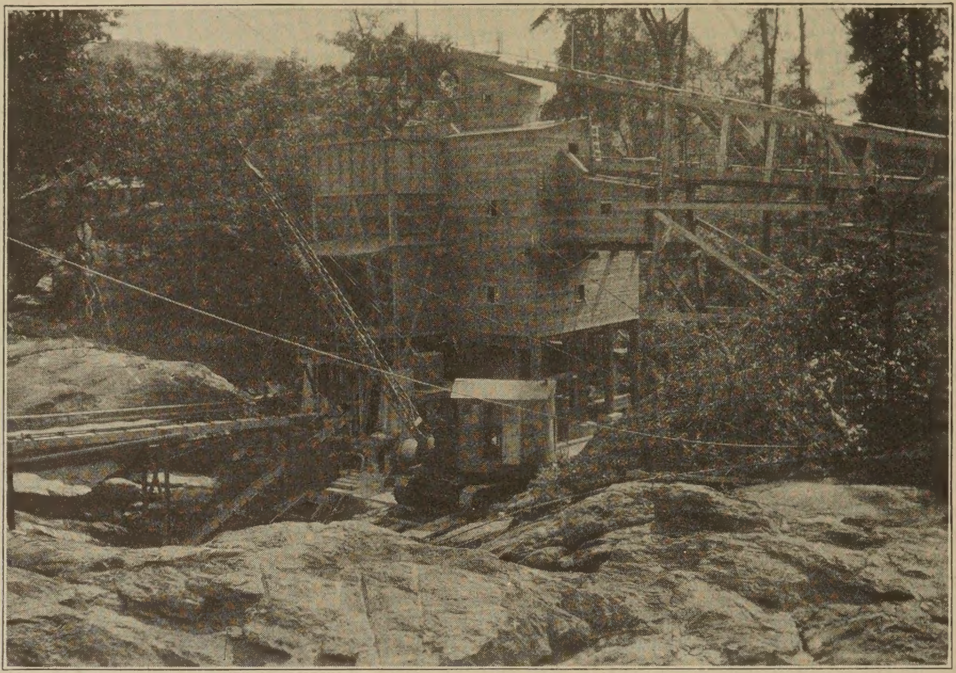
View of the anchorage from Riverside Drive

Concrete Control

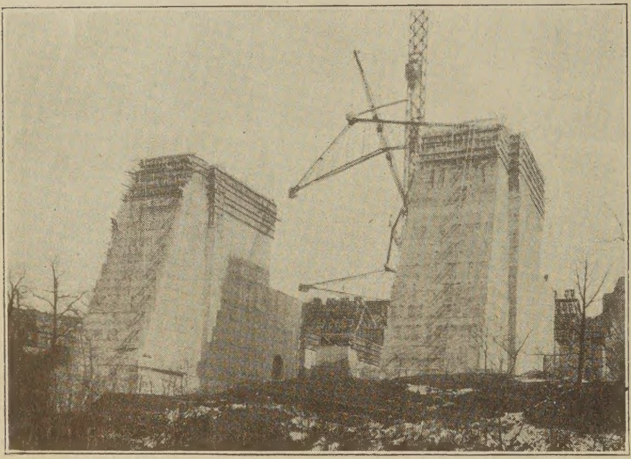
The concrete plant also has a space for a field laboratory, supplied with equipment for the control of the con-



Layout of the concrete mixing plant employed in constructing the New York anchorage showing method of conveying the concrete from the mixer to the hopper at the base of the distributing tower



A general view of the mixing plant. The belts at the top bring cement and aggregates from storage at the river shore 800 *ft. west and* 120 *ft. lower than the plant. The lower belt conveyor takes the concrete from the mixer to the tower hopper*



View of the anchorage from the west side

crete, where specimens are made for tests in compression, and the examination of the aggregates for moisture determination, in order that changes in the amount of mixing water may be made quickly.

The concrete was designed according to the water-ratio law for a strength, in compression, of 2480 lbs., at 28 days, with 7 gallons of water and 5 bags of cement per cu. yd. of concrete in place.

Test results from 257 8 by 16 cylinder test pieces broken at 28 days, with none eliminated, show an average strength of 2410 lbs. per sq. in., in compression, with 88 per cent of the specimens within 20 per cent of the average strength.

On January 20, 1929, 97,300 cu. yds. of concrete had been placed, which had used 477,454 bags of cement, or at the rate of 4.9 bags per yard. If these quantities were based on the proportion by loose volume instead of by weight, it would have required 5.6 bags per cu. yd. of concrete, a saving, as shown by these results, of .7 bag per yard, or at the rate of $.385 per yard of concrete placed.

The design and layout of the plant was made by E. P. Palmer and Howard B. Gates of the Arthur McMullen Company, the contractors on this part of the construction of the Hudson River bridge.

The work is under the direction of the Port of New York Authority with O. H. Ammann, chief engineer of bridges, M. B. Case, engineer of construction, and Robt. Hoppen, Jr., resident engineer.

Fifth Annual Reinforcing Steel Meeting

The fifth annual meeting of the Concrete Reinforcing Steel Institute will be held at Kenilworth Inn, Asheville, North Carolina, April 15th-17th. The program is rapidly nearing completion.

At the Tuesday morning session, April 16th, O. W. Irwin, vice-president of the Truscon Steel Company, is to deliver an address under the subject "Current Events."

Among the addresses of particular interest will be those by W. S. Thomson, chief engineer of the Kalman Steel Company, on the subject "Engineering Costs," and W. D. M. Allan, manager of the Cement Products Bureau of the Portland Cement Association, on the subject "New Markets for Reinforcing Steel."

On Wednesday, April 17th, the members will meet in executive session during the morning, elect officers and directors for the new year and will deal with matters of immediate interest and importance to the reinforcing industry.

The Wednesday evening session will be devoted to the subject of Concrete Ribbed Floor Construction. At this meeting it is expected that arrangements will be perfected by manufacturers and dealers in forms to create a special department of the Institute to deal with this activity. This will conclude the Institute sessions.

On Thursday morning, April 18th, a Trade Practice Conference will be held at Kenilworth Inn under the auspices of the Federal Trade Commission. It will be presided over by Judge Edgar A. McCullouch, chairman of the commission.

How to Put Color in Concrete

By R. R. McCOY
Geo. B. Smith Chemical Works, Inc., Springfield, Ill.

This is the age of color. Every industry has been forced to respond to this new, insistent demand. From kitchen utensils to skyscrapers, color is the vogue. Those who have met this new demand most fully have prospered greatest.

The demand for color is strong in the concrete industry, also. Concrete products of all kinds, cast stone, monolithic concrete and even concrete pavements have bowed to this demand. Today the concretor in every branch must be color-wise or yield to his more progressive competitor.

Here is a practical, helpful article on this live subject. No longer need the concretor fear for his colored concrete if he will select the proper pigments and follow the simple requirements of good workmanship.

COLOR pigments, to be satisfactory for use in cement work, should have the quality necessary to successfully withstand the action of sunlight; they should be fast to alkalies; free from acid or moisture, and should be of uinform quality at all times. They should be entirely free from gypsum or other adulterants, and free from soluble salts. They must be very finely pulverized and should not decrease the tensile strength of the cement. They should be insoluble in water.

In many cases a great deal of trouble has been experienced because the pigments used were not up to these standards. The use of the cheaper colors, such as those commonly used for coloring the mortar between bricks, do not, as a general rule, possess the quality or purity necessary to give the best results in cement work. The shades produced by pigments of the mortar color class are, in most instances, dull and muddy looking as compared to the shades produced by the use of more chemically pure pigments. Again, it is necessary, as a rule, to use so much of the color, of the mortar color class, to get even a fair tint in cement that it is apt to weaken the tensile strength of the cement.

Pure Cement Colors

Experienced manufacturers of concrete products and others engaged in the coloring of cement have found that the pure cement colors are not only the cheapest in the long run, but that they produce the bright, sharp, beautiful shades necessary to make their products or their work successful. It is the consensus of opinion based on the research work of various cement and concrete associations, and others interested in coloring concrete or cement, that the best results are obtained through the use of synthetically or chemically manufactured colors. These colors as a general thing, are more chemically pure; possess greater tinting strength; are more finely ground, and are capable of producing the clear, defined, beautiful shades most appealing to the public.

What Pigments to Use

The following classes of color can be depended upon to produce the best results in cement work:

Reds: Red Oxides of Iron, analyzing 98-99 per cent Fe_2O_3.

Yellows: Oxide of Iron Yellows. (Pure.)

Blues: Ultramarine Blues. (Pure.)

Greens: Chromic Oxide Greens, analyzing 98-99 per cent Cr_2O_3.

Browns: Brown Oxide of Iron, analyzing 98-99 per cent Fe_2O_3.

Blacks: Black Oxides of Iron, analyzing 98-99 per cent Fe_2O_3.

Reds:

We believe that the most satisfactory results can be obtained through the use of calcined pure red oxides of iron. By the term pure is meant, red oxides of iron that analyze in excess of 98-99 per cent oxide of iron (Fe_2O_3). These pigments, for the most part, are entirely free from acid, carry not to exceed ½ of 1 per cent moisture, and are very strong tintorially. They range in shade from a light orange undertoned red to dark blue undertoned red, known as Indian red.

Greens:

Chromic oxide green, in our opinion, is the best for use in cement work. It is the most stable of all cement color pigments. The pigment should run in excess of 99 per cent chromic oxide (Cr_2O_3) and should be free from sulphur, iron or other impurities. Chromic oxide green is, if pure, light, heat and alkali proof and is fast to all ordinary acids. The addition of a reasonable amount of chromic oxide green, it will be found, has a tendency to increase the tensile strength of cement.

Browns:

Brown oxide of iron, running in excess of 98-99 per cent Fe_2O_3, has proven itself to be the most satisfactory of all brown pigments, for cement work. It was formerly the practice, to some extent, to use burnt umbers and pigments of that class, but it will be seen by experiment that the iron oxide content of these umbers is generally so low that they do not have the ability to withstand the action of alkali or sunlight, and after exposure, fade out.

Yellows:

For the same reason assigned above, as to purity, pure iron oxide yellows are recognized as the proper pigment for producing that shade. The use of domestic ochres for this purpose is avoided, for the most part, on account of their inability to withstand the action of lime and the sunlight. Neither do the domestic ochres produce the beautiful shades obtained through the use of pure iron oxide yellows. Pure iron oxide yellows are very strong tintorially, and can be used in amounts that will not affect the tensile strength of cement or concrete.

Blacks:

Experiments and tests conducted indicate that black oxide of iron, sufficient to produce a jet black, strengthens the tensile strength of cement, which is not the case with carbon or lamp blacks.

Blue Undertoned Reds:

It has come to our attention that in such work as concrete topping, best results are obtained by the use of dark blue undertoned reds. All pure red oxides of iron run either to the orange or blue side, the lighter shades having the orange undertone while the darker reds have a blue undertone. Orange undertoned reds refract or throw back the rays of light which cause concrete topping colored with the light reds to appear faded. This is an optical illusion. Blue undertoned reds absorb the rays of light and appear to be more dense and consequently have the appearance of being more thoroughly colored than when the lighter reds are used.

This can best be explained to one not thoroughly versed in colors, by the fact that in the warmest climates, it is the custom for people to wear white or light colored clothing, which refracts or throws back the sun's rays, thus keeping the wearer more cool. Dark colored clothing absorbs the rays of sunlight, and for this reason is warmer. The more a colored object absorbs the light rays, the darker and more dense it appears.

Fineness of Grinding

The fineness to which a color pigment is ground plays a most important part in its ability to color concrete. The coloring matter used in concrete work does not saturate the particles of the aggregate, but coats the outside of each grain of sand or cement. It, therefore, stands to reason that the color which is the most finely ground is best. A pigment ground to a fineness of 200-mesh has approximately 8,000,000 particles per cubic inch, while a pigment ground to 300-mesh has approximately 27,000,000 particles per cu. in. It will, therefore, be seen that it is best to use the 300-mesh material, for the reason that there are more particles of color to cover the surface of each grain of sand and cement. This is what we mean when we state that the finest ground pigment has the greatest coverage or covering power.

Proportion of Color

It is very necessary, of course, that sufficient color pigment be used to give complete saturation or, in other words, that enough color be incorporated with the aggregate to sufficiently coat the surface of the particles of sand and cement so that they will not show through the coating of color. At the same time, it is essential that a color with a sufficient coloring power or coverage be used so that it is unnecessary to use an amount of color which would decrease the tensile strength of the concrete.

The amount of color to be used per bag of cement depends entirely upon the depth of shade desired.

With the class of colors heretofore referred to, in our opinion, 10 lbs. of color per bag of cement on a one to two or one to three mixture, will give very satisfactory results, without any decrease in the strength of the concrete.

In such products as concrete roofing tile, however, where the color is applied in a thin coat on the surface, it will be found that from twelve to fifteen pounds of color per bag of cement produces the best results.

It is advisable, in order to determine the exact shade which may be had by the use of a certain amount of color, to first make up small panels of the mortar, after selecting the primary color desired. The small panels should be made up using the same material and proportions as are intended to be used in the actual work. Variations of these shades may be effected by the use of more or less of the pigment. The panels will, of course, have a darker shade damp than when thoroughly dry. In all cases, the ratio of pigment, sand and cement should be kept constant. It is advisable to measure all material, including the color, by weight. Variations will result in the finished product if the batches of color, cement or aggregate are not measured accurately.

Selection of Material

Care should be exercised to use only the cleanest and best sand available. Dirty sand will counteract, to a great extent, the effect of the color, and will detract from the brightness and clearness of shade. All sand and cement should be free from lumps and should be reduced to as fine a powder as possible during the mixing.

Where delicate shades are desired, it is best to use white sand and white cement. The results obtained by the use of these white bases are superior to those secured when gray cement and river sand are used. A minimum amount of color will be required with the white bases. In the case of the dark colors, such as reds, browns, blacks, dark blues and greens, however, the gray cement and river sand give satisfactory results.

Mixing the Material

In order to secure the best results, all materials, including the color, should be mixed thoroughly in the dry form. After water has been added to form the proper consistency, all materials should again be thoroughly mixed. A very successful method is to mix the cement and color pigment in the proper proportions in a ball mill. This mixture is then added to the aggregate and the batch thoroughly mixed to a uniform color—both dry and after the water is added. The intensity of shade will be increased the longer the material is mixed.

To avoid mottling and secure glossy appearing results in concrete topping, all surface should be trowelled when it has set to the same degree of hardness. In other words, one portion of surface should not be trowelled when in a sloppy state and another portion when it is nearly dry. The nearer the topping is set when trowelled, the more glossy and beautiful it will appear. Trowelling should only be done in one direction when finishing surface.

Efflorescence

Efflorescence, or blooming, has always been a source of annoyance to manufacturers of concrete products. It is true that this condition is more noticeable when color is employed. The same condition exists in uncolored cement products. However, this condition should not be attributed to the color. Efflorescence is generally due to an excess of free lime or alkali in some of the materials used, other than the color. The class of colors referred to in this article contain no alkalis and are, therefore, in no way responsible for this condition.

As stated, efflorescence is generally due to an excess of free alkali in the materials used. In the process of drying, the evaporation brings this excess of alkali to the surface where it combines with the oxygen in the air and forms carbon dioxide, which is a whitish substance and which is not soluble in water. It is often found that concrete products which are dried quickly or in other words where the moisture evaporates quickly show a greater amount of efflorescence than when the drying out process is more gradual. Often the sand used is high in alkali—sometimes it may be traced to the water, and again to the cement, or a combination of all three.

In such work as concrete topping and in the manufacture of interior floor tile this trouble has been often eliminated by washing the efflorescence from the surface when it first appears and applying a solution of equal parts of kerosene and linseed oil. This has the effect of filling the pores of the cement and preventing the excess of alkali from coming to the surface.

Cascade Tunnel Concrete Placed in Eighteen Months

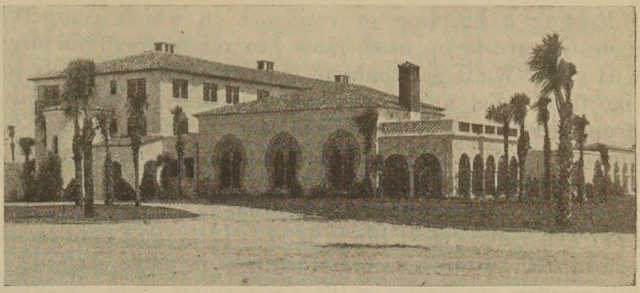
More than a quarter million cubic yards of concrete were poured in less than eighteen months in lining the Great Northern Railway tunnel in the Cascade mountains. The project is one-hundred miles east of Seattle and was recently completed.

The distance from the portals was too great to permit the concrete to be handled to the forms after mixing so mixing plants were designed for use at the point where the concrete was to be poured. As this point was constantly advanced the mixing plants had to be portable and despite the limited space afforded by a bore 18 ft. wide and 25 ft. high, they had to be so designed as to not interfere with the excavation operations going on ahead.

These controlling factors resulted in the designing of a structure 75 ft. in length which embraced in one unit both the mixing plant and the steel forms with sufficient clearance under the plant for the passage of the trains delivering the concrete materials and for the passage of the rock trains from the enlargement operations.

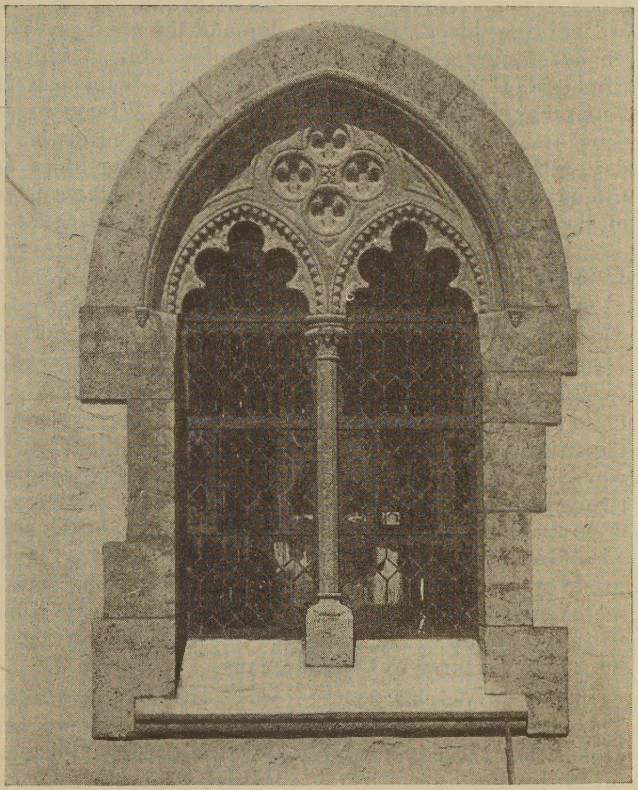
The walls of the tunnel were poured through chutes and holes in the sides of the forms while the arch was formed by shooting the concrete between the steel forms and the ceiling with a pneumatic gun. While the concrete hardened in one form work continued on another identical form several hundred feet ahead. While the latter was setting the crews moved to the third form, the first form being collapsed and moved ahead meanwhile. When the intervening spaces had ben concreted the three units were moved ahead. Eight of the specially designed units were used.

The pouring of the eight miles of two-foot concrete was started one and one-half years after the actual driving of the tunnel began and the last concrete was poured within twenty days from the day the last trainload of rock was hauled from the bore.



Island Hotel Structure Employs Concrete Extensively

The accompanying illustration pictures some of the interesting detail that is part of the Cloister Hotel, recently completed, at Sea Island, near Brunswick, Ga. The structure is of portland cement stucco on metal lath and is ornamented with cast stone. The patio is enclosed with an ornamental arch wall having a finish similar to that of the building. Mission tile is used as roofing on this 50-room hotel.



The structure is a part of the Howard E. Coffin development at the location. Mr. Coffin was ex-President Coolidge's host during the latter's vacation at Sapelo Island just previous to the termination of his office.

Addison Mizner was the architect, and the Sea Island Construction Company were the builders.

Demand for Pavements

No lessening in the demand for concrete pavements is in sight if automobile registrations reach the anticipated figure of 26,000,000 vehicles at the end of 1929. There are now about 24,500,000 passenger cars, trucks, and busses in the United States.

A Square Block for a Round Hole

By **ART SORENSON**

Passing a building or residence in which competing materials are being used, most progressive manufacturers will say: "We'll get concrete masonry in on the next job like that." Yet these same manufacturers pass by sewer projects in which competing materials are being used for the construction of manholes and catch basins without even considering the possibilities of concrete masonry for the job. It is indeed surprising that the market for manhole and catch basin block is so widely and continually overlooked. However, manufacturers in some sections of the country are awake to the possibilities of the business.

Many have taken advantage of the market that is constantly at hand and have been successfully merchandising manhole and catch basin block for several years. In Chicago and vicinity, for example, there is an average of at least 3,000,000 of the units used each year. One producer marketed over 500,000 manhole and catch basin block in 1927 and his 1928 sales will be even greater. The units are just as easy to manufacture as standard 8- by 8- by 16-block; in fact, the production cost of a single manhole block is about on par with the cost of producing the standard building block. Realizing this and the good prospects for developing a large market, manufacturers in Chicago, Elmhurst, Downers Grove, Franklin Park, Waukegan and La Grange, Illinois, Spencer, Iowa, Racine, Wisconsin, and Gary and Terre Haute, Indiana, entered the business. Today, although some of them produce building block and tile as well, the manhole and catch basin business is one of the greatest factors contributing to their success.

Quality Products

All of them market high quality block, adhering to the American Concrete Institute requirements for the individual units, and in many cases exceeding the institute's specifications for compressive strength and producing units having an absorption well under that required by the Institute. Having a good product to merchandise, one which engineers will readily accept, there is comparatively little difficulty, if any, encountered in getting concrete manhole and catch basin block written in the sewer specifications or placed on an alternate basis with clay brick or monolithic concrete. There are various ways to merchandise manhole and catch basin block. An illuminating example is furnished in the success experienced by a manufacturer in Gary, Indiana.

In this municipality much sewer work was in prospect. The city sewer specifications called for brick and brick alone. Yet the city engineer, ever alert for some means of improving the construction he was responsible for, was asked to try out manhole block. Possibly he had never heard of it before, yet he gave the block a fair trial. As a result he was favorably impressed and welcomed the chance to recommend manhole and catch basin block for other sewer work in his city.

Contact with engineers, consulting, sanitary and municipal, is extremely valuable, but no less so than contact with the ultimate users of manhole and catch basin block—the sewer contractors. Once a contractor becomes familiar with concrete manhole block, and that requires only a short period of experience, he is ordinarily more than glad to use his influence in having the units more widely specified. It is to the advantage of manufacturers of the product to seek the good will of the contractors. This is one of the first things a well-known Chicagoan, who specializes in making manhole and catch basin blocks, does when he is after new business. How does he do it? The following will tell:

Suppose a sewer builder is getting ready to build 50 or 100 manholes on an average sized job. The manufacturer already mentioned gives his contractor enough block to build a manhole, shows him how to build it and keeps accurate costs of units, labor and mortar and records the length of time it took to build the structure. Then he asks the sewer builder to build the same size structure out of a competing material, brick for example, and sees that the same set of cost records are kept. The results are good, of course, for there is ordinarily a saving of between 50 and 60 per cent in labor and 60 and 80 per cent in mortar when concrete block are used in place of brick. One concrete unit is equivalent in volume to 12 brick, and the concrete units are designed to fit with ease. The manufacture of concrete manhole and catch basin block is not a specialized business. It is everyday business for the manufacturer who is willing to merchandise an easily sold product for a profit. Today the concrete products producer reaches architects and builders in an effort to sell his products. Is it not just as easy to reach engineers and sewer builders? When a manufacturer talks to an architect, he has the merits of concrete masonry in mind. Manhole and catch basin block have similar merits. The block are segmental units of great strength, low absorption, reasonable cost and they are very economical in use. The conspicuous success of the block is now being recognized, with the result that many communities are investigating this material. This warrants aggressive promotion on the part of prospective manufacturers.

Will it not pay a manufacturer to place anywhere from 50,000 units upwards in manholes and catch basins in one season's time?

Furthermore, there are additional uses for concrete manhole and catch basin blocks. The units can be used for building underground structures in electrical work, gate-valve manholes for gas and water mains, cisterns, septic tanks, grease traps, and cesspools. Good markets can be found in any growing community.

In 1927 we sold approximately 60,000 manhole and catch basin units. The manhole being 48 in. in diameter with an average depth of 12 ft. The catch basin being 36 in. in diameter with an average depth of 8 ft. This gives you an idea of the comparative materials used for a 12-ft. manhole. It would take 209 blocks against 1569 brick, and 8 cu. ft. of mortar against 27. An ordinary mechanic can build three manholes a day against one built by a mason of brick. One contractor estimates he can build a manhole from blocks for about $25.00 less than if he used brick.

Summary

We can summarize the advantages of manhole and catch basin products as follows:

Permanence and strength. They will last an indefinite period.

Appearance. Walls being smooth, leaving less chance of sediments forming and deteriorating same if that were possible. They look attractive which always helps sales.

Economy. The saving in both labor and materials always interests the builder or engineer, which always helps sales.

In conclusion, remember it is just in recent years that manhole and catch basin blocks are becoming recognized so why not go out and get this business? Once you have sold the engineer and builder, they will sell themselves and you have added another good asset to your business.

A paper presented at the Wisconsin Concrete Products Association meeting at Milwaukee in January.

What Is a Well-Graded Aggregate?

Some New, Practical Information on the Use of Several Sizes of Aggregates Which Are Combined on the Job

By W. H. SMYERS
Supervisor of Tests, Duquesne Slag Products Co., Pittsburgh, Pa.

Experiments have shown that if a crushed slag coarse aggregate, ¼-in. to 2-in. in size, is screened into three sizes: ¼-in. to ½-in., ½-in. to 1-in., and 1-in. to 2-in., then the minimum per cent of voids will be obtained in a mixture containing approximately 50 per cent of the small size and 50 per cent of the large size and none of the middle size. Results indicate that this same principle likewise applies to rounded aggregates, and also to fine aggregates as well as coarse. To prevent segregation, it is deemed likely that coarse aggregates of the future will be delivered on the job in two sizes such as ¼-in. to ½-in. and 1-in. to 2-in., or else ¼-in., to ¾-in. and 1½-in. to 2½-in.

THE grading of aggregates affects many factors of concrete work, practically all of which are benefited by having a low percentage of voids in the aggregates. If the voids in the aggregate can be reduced, the following will be some of the advantages attained:

(1) Less mixing water will be required and thus strength will be increased.
(2) More yardage per bag of cement.
(3) Greater density and therefore less permeability to water.
(4) Greater strengths—compression, tension and transverse.
(5) Greater resistance to abrasion and wear.
(6) Less absorption.

It is the generally accepted view that a "well-graded" aggregate has less voids than a one-sized aggregate and most specifications for concrete coarse aggregate require that it be "well-graded." But what *is* "well-graded"? Because there are so many widely differing views as to what is meant by the term "well-graded," tests were undertaken to determine what grading would give the least voids.

Scope of Tests

Four series of tests were made within the last two years:

Series I: Three commercial sizes of slag: No. 3, No. 4, and No. 6.

Series II: Preliminary tests on three sizes of slag rescreened between ¼-in. and 2-in.

Series III: Extensive laboratory tests on three sizes of sand grains between 28 m. and 4 m.

Series IV: More complete tests on three sizes of slag between ¼-in. and 2-in.

The percentage of voids was determined in all cases by a variation of the so-called "displacement method." No attempt was made to correct for the slight absorption of the aggregates but, as all tests were carried out in the same manner, the results are considered reliable for the sake of comparison (if a correction were made for absorption, the true percentage of voids would be found to be slightly lower than the results recorded in this article). In Series I, II, and IV, either a 10-qt. bucket or a ½ cu. ft. cylinder was used as the container and was weighed empty and full of water in order to calculate its volume. Then two additional observations were made, namely, weight of the container full of slag (shaken), and weight of the same container and slag after water had been added level full. From these observations were calculated the density of the slag in lbs. per cu. ft., the apparent specific gravity, and the percentage of voids. Only the latter is recorded here.

In Series III a small paraffined cardboard cylinder about 1 in. in diameter and 2 in. high was used as the container. Such a small scale experiment was considered permissible in view of the small size of the grains of aggregate being used, namely, between 28 m. and 4 m. Such small scale experiments have the advantage of requiring much less time for completion and are probably just as reliable for the sake of comparative results.

The aggregates were cleanly screened to the limits indicated, in all series of tests except No. 1 in which the three commercial sizes of slag were used, of which the nominal limits are shown under Table I. It should be remarked that those sizes overlap somewhat. The only difference between Table II and Table IV is that in Table II no particular attention was paid to the exact screen analysis of each of the three sizes further than to see that they fell within the limits indicated; whereas, in Series IV, the coarse size (from 1-in. to 2-in.) was artificially made up of 50 per cent of 1-in. to 1½-in. material and 50 per cent of 1½-in. to 2-in. and likewise for the other two sizes of aggregates used in that series of tests.

Discussion of Results

All four series of tests show that the voids were reduced to a minimum in mixtures containing approximately 50 per cent of the largest size and 50 per cent of the smallest size and none at all of the middle size. They likewise indicate that when even a small percentage of the middle sized aggregate was added to such a mixture of equal parts of large and small, the voids were increased above this minimum. These tests also showed that mixing two sizes of aggregate which merge one into the other in screen analysis (without a gap in between) does not appreciably reduce the percentage of voids. The tests in Series II also showed that in a commercial crushed slag coarse aggregate ranging from ¼-in. to 2-in. in size, the voids were reduced from 43 per cent with a standard grading down to 39½ per cent with the proposed new grading. Likewise Series IV showed that with a slag of standard grading the voids were reduced from 41 per cent down to 36½ per cent with the proposed new grading.

This new grading was found to reduce the voids in fine rounded sand grains as well as in large crushed slag coarse aggregate. It would seem fairly safe, therefore, in concluding that this principle applies in a general way to all aggregates regardless of size or shape.

As mentioned previously, such a relatively large reduction in voids will quite naturally affect many of the other factors of the concrete work and it is intended that these experiments be continued to study just to what an extent and in what manner this proposed grading will affect each of those factors. It is believed likely (and future experiments should be made to ascertain this definitely) that the following advantages will be attained with this new grading:

1. Less mixing water should be required (and thus the strength should be increased).
2. A greater yield or yardage of concrete per bag of cement should be obtained.
3. The concrete should be more dense and therefore less permeable to water.
4. The concrete should be stronger in every respect. (Compression, tension, transverse, etc.)
5. Due to the increased density, the concrete should have a greater resistance to abrasion and wear.
6. The concrete should likewise have a lower absorption.

Commercial Application

As to the commercial application of such a problem, one solution to it might be, for example, in concrete work, to use two separate sizes of coarse aggregate. Such

TABLE I.—SERIES I.—*Slag Coarse Aggregate*

	Test No.	2	3	4	5	13	8	15	16	21	22	23	24
Per Cent by Weight	No. 3 slag	100	100	—	—	—	75	—	—	80	75	67	50
	No. 4 slag	—	—	100	100	—	25	67	75	—	—	—	—
	No. 6 slag	—	—	—	—	100	—	33	25	20	25	33	50
Per Cent Voids		50	50	55	50	55	55	50	50	42½	42½	40	42½

Nominal Limits

Size No. 3	1-in. to 2¼-in.
Size No. 4	¼-in. to 1-in.
Size No. 6	3/16-in. to ⅜-in.

TABLE II.—SERIES II.—*Slag Coarse Aggregate*

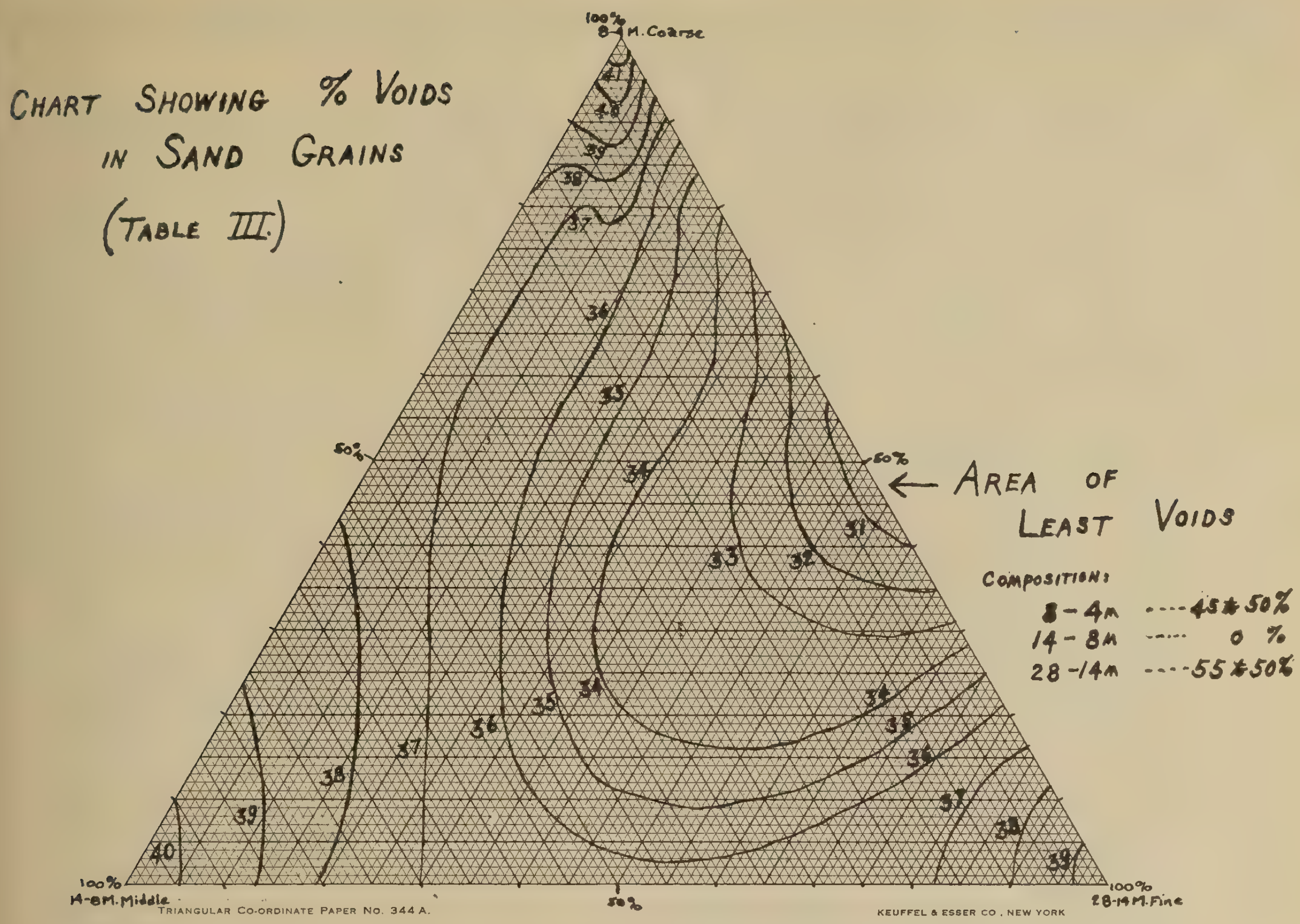
	Test No.	1	2	3	4	5	8	7	9
Per Cent by Weight	Coarse (1-in. to 2-in.)	100	—	—	40	50	50	60	50
	Medium (½-in. to 1-in.)	—	100	—	50	35	50	—	—
	Fine (¼-in. to ½-in.)	—	—	100	10	15	—	40	50
Per Cent Voids		45.3	45.3	44.6	42.8	43.0	44.6	39.5	39.5

TABLE III.—SERIES III.—*Sand Grains* (See diagram on following page)

	Test No.	1	2	3	4	5	6	7	8	9	10
Per Cent by Weight	8 m.-4 m.	100	—	—	90	80	70	60	50	90	80
	14 m.-8 m.	—	100	—	10	20	30	40	50	—	—
	28 m.-14 m.	—	—	100	—	—	—	—	—	10	20
Per Cent Voids		41.7	40.8	39.8	39.0	37.8	37.8	37.5	37.8	36.9	33.5
	Test No.	11	12	13	14	15	16	17	18	19	20
Per Cent by Weight	8 m.-4 m.	70	60	55	50	40	20	—	—	—	80
	14 m.-8 m.	—	—	—	—	—	—	70	50	30	10
	28 m.-14 m.	30	40	45	50	60	80	30	50	70	10
Per Cent Voids		32.7	31.5	31.5	30.7	33.0	36.1	37.0	36.6	36.4	36.6
	Test No.	21	22	23	24	25	26	27	28	29	30
Per Cent by Weight	8 m.-4 m.	70	60	50	40	20	70	60	50	45	40
	14 m.-8 m.	15	20	25	30	40	10	10	10	10	50
	28 m.-14 m.	15	20	25	30	40	20	30	40	45	10
Per Cent Voids		36.0	34.9	33.8	33.2	34	36.1	35.5	34.1	31.2	36.6

TABLE IV.—SERIES IV.—*Slag Coarse Aggregate*

	Test No.	1	2	3	4	5	6	7	8	9	10	11	12
Per Cent by Weight	Coarse (1-2-in.)	100	—	—	45	50	35	40	45	50	55	60	65
	Medium (½-1-in.)	—	100	—	45	50	—	—	—	—	—	—	—
	Fine (¼-½-in.)	—	—	100	10	—	65	60	55	50	45	40	35
Per Cent Voids		47.1	45.8	45.4	40.8	43.8	38.5	37.2	37.2	36.5	38.2	38.8	40.5



a method has already been used this year on a number of road jobs in various parts of the country but in all cases observed, the two sizes of coarse aggregate merged one into the other as far as size limits are concerned without leaving a definite gap between them. If such a new grading as proposed above proves practical, instead of using two sizes of coarse aggregate such as ¼- to 1-in. and 1- to 2-in., the size limits will probably be from ¼- to ½-in. and 1- to 2-in., or else in case a larger maximum size can be used, the smaller aggregate could be ¼- to ¾-in. and the larger one could be 2- to 3-in. or perhaps even 1½- to 2½-in. Such a procedure might involve considerable difficulty in batching plants for building construction or road construction jobs but it might prove easily adapted to plants which make a ready-mixed concrete. The exact manner in which this new grading could be or will be used commercially can, of course, only be guessed at the present time.

Name Group to Study Curing of Concrete Pavements

The Executive Committee of the Highway Research Board, National Research Council, announces the formation of a special committee to conduct an investigation of the problem of proper curing methods for concrete pavements. The work will consist largely in correlation of the research work being carried on by the Bureau of Public Roads and various state highway departments.

The committee consists of F. C. Lang, University of Minnesota and Minnesota state highway department, chairman; E. F. Kelley, chief of the division of tests, U. S. Bureau of Public Roads, Washington, D. C.,; W. A. Slater, research professor of engineering materials, and director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.; F. V. Reagel, engineer of materials and tests, Missouri state highway department, Jefferson City, Mo.; Frederick E. Schnepfe, civil engineer, Washington, D. C.; H. F. Gonnerman, manager, research laboratory, Portland Cement Association, Chicago, Illinois; and Stanton Walker, director of engineering and research division, National Sand and Gravel Association, Washington, D. C.

The work of the investigation will be carried on by Fred Burggraf under the general direction of R. W. Crum, director of the board.

Well-Built Roads Take Place of Bridges in Arroyos

Without constructing expensive bridges, the New Mexico Highway Department is making the crossing of mountain arroyos safe for the autoist. Washes from the mountainsides are usually dry but when the heavy rains collect and rush to the valleys below there is usually a deep channel cut across the roadway.

Concrete roadways are built with well anchored and deep side foundations across the arroyo, allowing the flood waters to rush over the roadways. Many of these are several hundred feet long and water two to three feet deep crosses many of them for a few hours at a time during a heavy rainstorm.

To guide the driver as well as to show him the depth of the water he necessarily has to ford, concrete posts are set at intervals along the concrete roadway. Some of these have small culverts to allow small amounts of water to pass or where there are small running streams a bridge with capacity for normal flow is provided.

P. G. RILEY
President

P. G. RILEY
GENERAL CONTRACTOR
~~701 Temple Street, Pittstown, N. Y.~~
Los Angeles

T. G. McGOVERN
General Supt.

Dear Mac:

SUBJECT: The Passing of Old Rain-in-the-Face

The other night I had another visit from old Jim, the Night Watch, and after he had gotten under way with a quarter of a package of scrap, he said: "Well, Old Timer, there goes Old Rain-in-the-Face."

"What for, and why the name?" I asked.

"Rain-in-the-Face," says he, "because that old concrete mixer spurts out water every whichway, like an excited tobacco chewer without any front teeth spits tobacco juice, and we are losing our dear old friend, much to the boss's dismay, and the superintendent's joy, because the old boy doesn't seem to get along with the inspector.

"You see, Old Timer, when Old Rain-in-the-Face was the joy and pride of the force it didn't seem to make much difference where the water went, or how much got into the drum, it being sort of measured by eye, which wasn't so very accurate on account of sometimes the measurer's eye got full of water or dust.

"Yes, sir, we've smiply got to have educated mixers now, physically fit, without kidney trouble. Mixers that won't get constipated with this sticky aggregate, and mixers that will say 'Let's go' just at the right time.

"Now, Old Timer, I may be old, but I am not set in my ways; I kinda like these new mixers, darn if I don't, they're so blamed businesslike."

"What's the new idea now, Jim?" I prodded.

"Well," says he, "don't know as I can give it to you like the inspector could, but it seems like everything has got to be measured accurately—water, mixing time and aggregate must be perfectly related, so to speak. They are calling for less water, perfectly measured water, and longer mixing time. To get this it appears to me like the contractor will have to watch his step in buying concrete mixers and get them designed right and made darn good.

"If they are going to stretch out the time of mixing something has to done to speed up the daily capacity in some other ways, and it appears to me like larger machines will have to be used, too.

"By Cripes, the boss sure has changed his ways. I recollect the time he bought Old Rain-in-the-Face. He had everybody who ever made a mixer a-workin' on him; one fellow prayed damned near all night with him, and the next morning Sandy says to him: 'Now I tell you, you just give me a price on the drum and fixin's. I can get an engine cheap and can get the truck and wheels down here at the old wagon shop.' Right then the fellow blows up and tells Sandy to go plumb to Hell; that he couldn't have his mixer anyway, and if he had said that a couple of days before he'd have saved himself a lot of time and trouble, 'cause Sandy sure wanted that mixer the worst way then and bought it as is.

"Now price don't seem to bother Sandy; the only thing that bothers him now much is—'Am I getting the best there is?'

"Why?" I prodded.

"Well," said Jim, "I ain't hankerin' after the job. You'd think there wasn't so much difference in mixers, think maybe they were all the same mess of pups, but they sure ain't. Say, I sure would make 'em trot a heat or two before I paid them."

"Yes, but what manufacturer would want to make a used machine out of a trial mixer, or what contractor would want to bother with trying them at all?" I asks.

"Well," says Jim. "What I would do, I'd just watch each of them for a spell on some other jobs and I'd pick one that seemed to travel easy and looked like it might live a long time, and then I'd ask the daddy of him to let me hire him for a spell on my own work. Yes, sir, that's what I'd do, by Cripes.

"Say, Old Timer, you got any more of that scrap?" and I left Jim going his rounds and went home, but I couldn't help but think, Mac, it costs money these days to keep up to date, but then on the other hand it costs money not to. It's like old Dow Armstrong used to say: 'It's be damned if you do and be damned if you don't.' Sometimes I'm glad I'm passing the buck to you these days.

P. G.

~ EDITORIAL ~

Grading of Coarse Aggregate

THE scientific grading of coarse aggregate by combination of two and sometimes three separated sizes in the proportions that will produce the maximum practical density is gaining momentum, especially in concrete pavement construction. Products manufacturers, also, have found this procedure desirable.

Several state highway jobs have been completed under these methods and the U. S. Bureau of Public Roads has gone on record as definitely recommending them.

In an article in this issue, published under the title "What Is Well Graded Aggregate?" some additional data regarding this subject are given. Favorable results with the use of two separated sizes of aggregate are shown.

Here is an opportunity for aggregate producers and material dealers to co-operate with concretors. The use of such methods of combining aggregates will undoubtedly increase and those dealers who are in the fore in supplying them will gain a distinct advantage.

Products Plant Production

IT is impossible to consider merchandising and production methods as they relate to the concrete products industry separately. The one inevitably suggests the other. More intensive merchandising brings with it a production problem and greater production automatically must mean more sales.

One of the outstanding impressions a visitor to products conventions receives is the wide diversification of opinion on what constitutes a fair production, either from the point of view of block per man per day or block output per machine. One man talks of 200 blocks per man per day as satisfactory. Another places the figure at 600!

Undoubtedly, local and individual plant conditions do much to affect this figure. But, after all, need there be such a wide variation? Granted moderately efficient plant layouts and similarity of equipment, are the men in one plant three times more efficient than the men in the other plant? Or is the layout three times as efficient in one plant as in the other?

In either case the problem resolves itself pretty much into a management problem. Products manufacturers as a whole are not yet management conscious. Even if the 600 block figure should be incorrect and due to some peculiarity, still there is too wide a range in production records.

Products plants are becoming more and more automatic in operation. Machinery is entering into the picture to a greater extent than ever before and indications are that it will be even more important in the future. Larger plant investments and lower labor costs will result. But if the ultimate total cost of the unit will be reduced, it will be only through more efficient management. The investment in plant and machinery must do its share.

Performance Records

THIS month we describe another outstanding example of concrete performance in the story featuring the present condition of the thirty-two year old concrete bridge at Topeka, Kansas.

In the light of present-day knowledge of making and placing concrete, the Topeka bridge job was not an exemplary job. Yet, in spite of its obvious shortcomings, it is a job that concretors may point to with pride. Thirty-two years of satisfactory performance are already accomplished and, with slight repairs, another long period of usefulness lies ahead.

There are many such records of enviable performance in the history of concrete construction. They indicate what may be expected of concrete as an engineering construction material. We can well agree with E. D. Boyer, president of the American Concrete Institute, when he said at the recent convention that he personally knew of hundreds of cases where concrete under a wide variety of service and exposure conditions rendered long service of the highest order and that he thought such performance records should be recorded.

Concrete is as nearly a permanent construction material as can be found. Its high qualities should be more generally recognized. Engineers have every reason to build with assurance when concrete is used.

Now, as more scientific data regarding the behavior of concrete under varying conditions of exposure are being collected, we can look forward to even more satisfactory performance records. Already many facts are known from examinations of old structures and from laboratory experiments. It is not unreasonable to expect that in the near future it will be possible to ***know*** definitely that concrete placed in structures subjected to severe conditions will withstand destructive agencies for a definitely determined time.

The difficulty is to get engineers and contractors to capitalize to the fullest possible extent on that knowledge of concrete making that the industry already possesses and to make full use of all those aids that insure better workmanship in the field. For, in the last analysis, it is the men on the job out in the field that have the last word. On them depends the story that the job will tell. On them depends the ultimate welfare of the entire industry.

The Light-Weight Aggregate Field

Some Detailed Information Regarding "Pottsco," a New Light-Weight Aggregate—What It Is—How It Is Used

By H. H. POTTS
H. H. Potts Company, Chicago

THE tremendous development of the use of light-weight aggregate in the manufacture of concrete building units in the very recent years has provided unusual opportunities to all concrete products manufacturers. Indeed, it has made possible a very marked increase in production both actual and potential. It might be said that it has afforded the opportunity of adding an entirely new and substantial wing to the business without a corresponding increase in investment. That is to say, remarkably increased production can be afforded by the use of the present or at least very slight additions to plant facilities including buildings, equipment and overhead expense.

The production of light-weight concrete units does not necessarily need to affect the ordinary or usual production of standard concrete units, since the market for light-weight units generally lies in the displacement of competitive materials in construction where concrete units heretofore have not been extensively used. This is particularly interesting because concrete units are used in approximately only 25 per cent of the construction where they might be successfully employed. This, therefore, offers an almost unlimited opportunity in any locality for their increased use.

The special qualities and advantages of light-weight aggregates, which have been on the market for some time, have led and are leading to the unqualified endorsement of state and city building codes, architects and builders. With this condition established and confronting the manufacturers and producers of materials used by the industry generally, we have given serious study to and performed much research work in the development of light-weight aggregates, the supply of which will, to some extent, keep pace with the increased demand and market therefor. Our company in common with certain others has for some time been active in this phase of the industry. It was not, however, until August, 1928, that we perfected a light-weight aggregate which is now on the market and being successfully used by many plants. Under the trade name of "Pottsco," we have developed a light-weight aggregate which meets all the requirements of such a product.

First or, at least equally important, with qualities required in general is a reduction in weight of from 35 to 40 per cent under standard concrete units. This product has the advantage of being nailed easily and has exceptional holding qualities. Tests have proven it requires more pull to extract nails from Pottsco blocks than from pine timbers. The absorption qualities are highly satisfactory, and range from 7 to 18 per cent depending upon the tamping, density and other conditions surrounding the manufacture of the units.

The Market Possibilities

While we recommend the use of these blocks as a back-up unit, they are used in some walls below grade and for exposed walls above grade. But where so used, exceptional precautions should be taken in their manufacture to insure the greatest density and lowest absorption with perhaps the addition of admixtures which still further lower the percentage of absorption. The very light color as well as the smooth surface and good texture contributes to an incentive to use them for exposed walls above grade, but their use in this class of construction will generally be limited, if not prohibited, in localities quite distant from the source of supply and point of shipment, from the standpoint of cost, since freight rates make the delivered cost somewhat greater than the ordinary sand, gravel and limestone aggregates, and it will be generally found that these units cannot meet the price competition of units manufactured from local supply of aggregates.

The units further possess qualities for insulation and sound deadening. Both of these factors are highly important in any light-weight concrete unit used for back-up work particularly in larger buildings, including apartments. They are also efficient from the standpoint of fire resistance. Compression strength of units manufactured by various plants using Pottsco range generally from a minimum of 750 pounds to a maximum of 1400 pounds per square inch, gross area, depending on the type of machine in which the blocks are made, the amount of cement used, the curing facilities and the length of curing time. Taken as an average, the units are approximately 1,000 pounds per square inch, gross area, in compression strength.

Characteristics

The aggregate in dry form weighs approximately 1,200 pounds per cubic yard, but production process is such that the material always contains a certain amount of moisture when loaded and received. The actual weight per cubic yard as loaded ranges from 1500 to 1600 pounds, but as an allowance for moisture content and to offset the penalty for freight charges on moisture, a cubic yard is considered arbitrarily as 1800 pounds. The yield from this arbitrary 1800-pound yard ranges from 55 to 65 standard 8 by 8 by 16-in. blocks, the variance being due to different percentages of air space and the degree of tamping. The units weigh from 29 to 34 pounds as actually produced with an average of approximately 31 pounds. The relative fineness of the aggregate makes a very efficient unit from the standpoint of sawing, cutting or boring. However, it is not been found that the relative fine aggregate increases substantially the consumption of cement since the plants manufacturing these units are securing from 16 to 22 blocks per bag of cement and securing the compressive strength and absorption above cited.

While the production and supply of Pottsco is somewhat limited, a very large production is available and in order to scatter the market as much as possible, it is the policy of the company to award with the sale exclusive territorial manufacturing rights protecting the customer with a contract, guaranteeing price and delivery for a term of years and for the territory agreed upon.

A general view of one of America's oldest concrete bridges. The middle five spans were built in 1897. *Two spans at each end were added in* 1905. *The ice breakers were built in* 1927

After 32 Years of Service

—*A Striking Example of Concrete Performance*

By **NORMAN M. STINEMAN**

Continuing the discussion of service records of old structures, begun in the report of the American Concrete Institute convention in last month's issue, we present this month a survey of the present condition of the old Melan arch bridge at Topeka, Kansas, built in 1897.

THE 32-year-old Melan type concrete and steel multiple-arch highway bridge over the Kansas River at Topeka, Kansas, joining the main part of the city and North Topeka, furnishes a worth-while example of the performance of this type of design. The performance of this bridge should, however, be considered only in conjunction with the details of design and the quality of construction. Certain details of design are completely at variance with present-day practice, and the quality of construction would today be considered much below average.

Built in 1897

The greater part of the Topeka bridge, consisting of five arch spans, was built in 1897. Four additional arch spans were built, two at each end, in 1905. These later additions have clear spans of about 80 ft. Of the five arches built in 1897, the central arch has a clear span of 125 ft. The second and fourth spans are 110 ft. each in the clear, and the two end spans are 97 ft. 6 in. in the clear. The total length of this part is about 650 ft. The roadway is 26 ft. wide, and there is a 6-ft. sidewalk on each side, so that the total width, including the railings, is 40 ft.

The main part of the bridge, built in 1897, was financed by Shawnee County. Name plates contain the information that it was designed and built by Keepers & Thacher, of Detroit, Mich., with William Tweeddale as resident engineer and F. L. Gaines as superintendent. The names of county officials on a plate near the south end of the bridge include H. V. Hinckley, superintendent of construction, and J. L. Campbell, assistant superintendent.

The additional spans built in 1905 were financed by the city of Topeka. Apparently North Topeka had been taken into the city between the two construction dates. Name plates on the two north spans of these later additions mention the Concrete Steel Engineering Co. as designers and consulting engineers, and the Marsh Bridge Co., Des Moines, Iowa, as builders. The city officials' names are James F. McCabe, city engineer, and W. E. King, assistant engineer.

The Topeka bridge is not a true reinforced concrete structure. It is known as the Melan arch type, a type in which light structural steel arches, spaced 3 ft. apart in this instance, are completely imbedded in the concrete barrel. The steel arches support the formwork for the concrete during construction, and after the concrete has hardened, they serve as steel reinforcement. Because of a fundamental difficulty involved in construction, this type of arch bridge has lost favor and has not been employed by designers to any considerable extent for many years.

An examination of this bridge on October 8, 1928, revealed some most surprising details of construction, which seem less surprising, however, when we consider that the designers and builders had but little previous practice to guide them. Nevertheless, the trouble originating from two of these details might well have been anticipated. Both are errors of omission, rather than commission.

One is the lack of expansion joints, not a single joint having been provided. Presumably the designers believed the combination of structural steel and concrete would take up and distribute the expansion stresses in a way that would not be harmful to the structure. The other important error of omission is the absence of weep-holes.

There is one weep-hole in one of the later additions, on the north side of the first pier from the north end, near the spring of the arch; but there is evidence that it may have been put in some years after this extension to the bridge was built. Two other weep-holes in the barrel of the southernmost arch were installed quite recently, a fact clearly indicated by the freshly broken concrete exposed where the hole was broken through. These drains consist of ⅝-in. pipes. At the time of the examination there was no leakage in evidence in the vicinity of these two weep-holes, or drains; but the presence of much lime on the surface indicates that penetration of water had occurred here and that the drains were installed in an effort to prevent disintegration. The freshly broken concrete at these drains has the appearance of being sound.

Concrete Appears Sound

The appearance of the concrete in this bridge, where it has not been affected by seepage, is fairly satisfactory. Some cracks have been formed, probably because of the omission of expansion joints, but they are not serious. The surface of the concrete is weather-beaten, but there is no disintegration except where seepage has occurred, and in "day's work" planes.

The condition of the concrete where it is not directly affected by seepage from the spandrel fill is, in fact, surprisingly good when the leanness of the mixture is taken into consideration. The piers, for instance, were built by placing a natural cement concrete from a level several feet below the tops of the piles up to a level 1 ft. below low water. The mixing proportions for this part of the work are not known; but the natural cement used was known as Diamond cement from Middlebranch, Kentucky.

Lean Mixtures Used

Above this natural cement concrete footing the mixture used was a 1:4:8 portland cement concrete, the cement used having been Aalborg portland cement imported from Denmark. Several thin layers of a richer mixture were placed on the natural cement concrete footing before the regular 1:4:8 mixture of portland cement concrete was placed. These layers consisted of a 1-in. thickness of a 1:2 portland cement and sand mortar, then a 7-in. layer of 1:2:4 portland cement concrete. The coarse aggregate was crushed limestone.

The 1:4:8 mixture was used for the rest of the structure, except in certain ornamental work. For instance, the keystones, brackets and consoles, which were molded separately and set into place, were faced with 1:3 mortar to an average thickness of 1 in. The concrete in the body of these detached ornaments is a 1:3:3 mixture. The same composition was used in making the ornamental work that was cast in place, such as the cornice, the railing posts, panels and curbstones.

The damaging effect of the seepage through the arch barrels, next to the piers, may easily be realized from the fact that water was dripping through all the seriously affected parts and through the few weep-holes provided, at the time of the examination, although the weather was then very dry. Very little rain had fallen at Topeka during the previous four or five weeks. Large volumes of water must have accumulated in the spandrel fills during wet weather, in quantity sufficient to keep up the seepage during dry periods. In the earlier life of the bridge this water was impregnated with acids from manure, and later with oil and grease from automobiles.

Disintegration Due to Lack of Weep-Holes

All serious disintegration of concrete in this bridge must be ascribed directly to the absence of weep-holes, which caused water to accumulate in the spandrel fill and to seep through the piers and through the arch barrels in the immediate vicinity of the piers. Much disintegration has occurred in the piers themselves; but the fact that water was dripping through at all seriously disintegrated places proved beyond a doubt that it was coming from the accumulations in the spandrel fill. That was the only possible source from which water could have been coming at the time of the examination.

The present condition of the bridge need cause no

The upstream side of the Topeka bridge at Topeka, Kansas, as seen from the south. The spandrel walls, in spite of the lean concrete used are described as being in fair condition The ice breakers were added in 1927 alarm, but the disintegration will continue from year to year until the cause has been removed. Thorough-going repairs would involve less work and expense now than ten years hence.

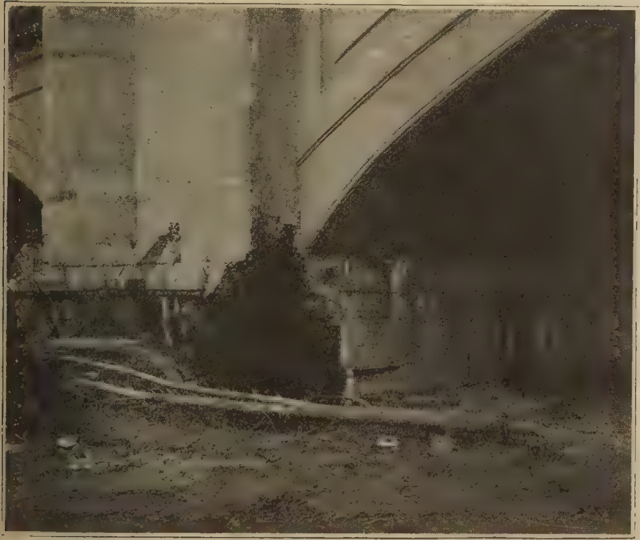
The illustrations show the extent of the disintegration in certain places. For the sake of recording the present condition of the bridge, however, it will be well to describe the disintegration in some detail.

Stalactites have formed on the under surface of the arch barrels of the first and second spans from the south end. Water was slowly dripping from them. Some of the stalactites were knocked off and examined, but not chemically analyzed. They consist of a light-colored substance, soft at the tip and hardened at the base.

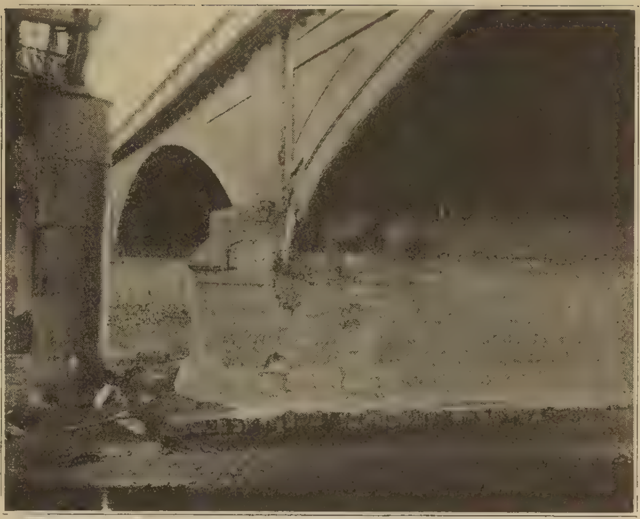
Much seepage was coming through the first and second piers from the south end, and through the adjacent arch barrels near the spring of the arch. The first pier is badly disintegrated at both ends, and the second pier has suffered in a similar way at its west end. Cottonwood shrubs, weeds and grass are growing in the disintegrated material at these points. The second pier originally was the south abutment of the main part of the bridge, built in 1897. Water is seeping through the south face of the second pier near the center-line of the bridge, but no serious disintegration has occurred, except that some of the "day's work" planes in the pier are disintegrated to a depth of 6 or 8 in.

Near the north end of the bridge, on the north side of the first pier from that end, a pocket has been disintegrated to a depth of about 6 in. over an area of less than 2 sq. ft. It is here that a weep-hole was installed, probably some years after the bridge was built. There is disintegration to a smaller degree on the opposite side of the same pier. The third pier from the north end has disintegrated considerably at its downstream end, near the spring of the arch. The other three river piers are disintegrated in much the same way.

Much disintegration has occurred immediately underneath the bottom chord of the structural steel arches or ribs, where the concrete was not properly puddled into place. This condition is more prevalent in the newer additions than in the original bridge. Many of these strips have been patched with mortar, but in some places the structural steel is still exposed, more especially in the north two spans.



Showing the disintegration at the west end of the second pier of the Topeka bridge, from the south end. This was originally the south abutment of the bridge, built in 1897. That water accumulates in the spandrel is evidenced by its dripping at this point after prolonged dry weather



This is the downstream end of the third pier as seen from the north end. The disintegration here, as elsewhere, is due to the seepage of accumulated water in the spandrel fill

Aside from the patching mentioned, some repairs were made by placing new concrete around the base of the four river piers at the time they were provided with ice-breakers in 1927. Mention has also been made of three weep-holes that have been installed, two of them recently.

Repairs Suggested

Notwithstanding the lean concrete in this bridge and the disintegration that has occurred, it will be possible and feasible to repair it in a way that will prolong the life of the structure many years. First of all, the outstanding cause of the trouble must be removed, by providing a sufficient number of weep-holes. In that way, and in that way only, can the destructive action of the water seepage be stopped.

The next logical step in making repairs is the removal of disintegrated concrete and its replacement by new concrete. For some of the repair work a cement gun could be used to good advantage. Consideration should also be given to the use of a cement gun to resurface the arch barrels. As to the piers, their disintegration could be stopped if, after removing disintegrated material, a 6-in. jacket of new concrete of the highest quality were placed all around them and up to the springing line of the arches. Concrete for this purpose should be of the highest strength and density obtainable, well-bonded to the old concrete and placed under the most careful supervision.

Landing Field Construction To Be Discussed in Airport Convention

Landing field construction and the design and architecture of airports will be discussed when the Aeronautical Chamber of Commerce of America, Inc., meets at Cleveland, Ohio, May 16th to 18th. This will be the first airport convention ever held, according to an announcement by Captain Clarence M. Knox, vice-president in charge of the airport section of the Aeronautical Chamber of Commerce. Mr. Knox, who is commissioner of airports of Connecticut, with headquarters at Hartford, states also that the convention will be an annual affair.

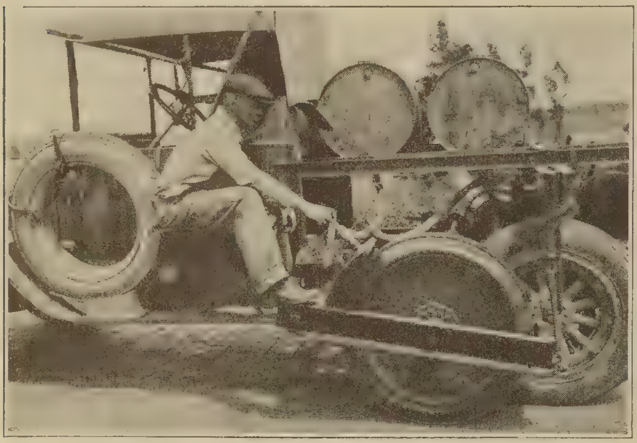
The tentative program includes in addition discussions and addresses on various phases of airport lighting, inter-field communication and meteorology, safety control, maintenance and administration, and standards of practice.

The office of the chamber is at 300 Madison Avenue, New York City.

Practical Kinks from the Job

Center Line Painting on Iowa Highways

A specially equipped war surplus truck is marking a wide, black line along the concrete highways of Iowa at the rate of two miles an hour. Attached to the front cross member of the truck frame is a motorcycle wheel fitted to a pipe frame for the purpose of guiding the truck in a substantially straight line. Where the pavement has not been marked before this guide wheel runs along the pavement edge while on marked pavements the wheel is made to follow the painted stripe.



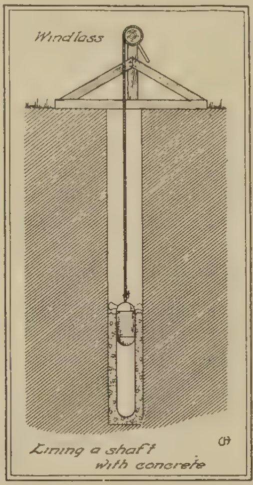
Two fifty gallon barrels are placed on a framework constructed on the truck for carrying the paint and applying it to the painting device by gravity. The device used for marking is an ordinary truck wheel carried in a steel frame attached to the left hand side of the truck. The frame is arranged so that the marking wheel may be raised to clear the pavement where necessary. The solid rubber tire of this marking wheel is slightly concaved and this cup produces a maximum pressure at the edges of the line so as to make a neat and clean mark.

A nozzle connected by an ordinary hose to the paint barrels on the truck is placed directly over and close to the marking tire. The flow of paint from the nozzle is directed onto the marking tire and a metal windshield protects the operator from being spattered with it if the wind should blow. The operator is seated facing the rear so that the marker and its operation are always in full view.

Concrete Lining for Shaft

The method shown in the accompanying illustration for lining a shaft with concrete was used originally in a hole in a private cellar. Because of its simplicity and effectiveness, however, the plan can be used in a large number of instances where a fairly uniform wall of concrete is wanted and can be used in holes that are vertical, from 10 inches or thereabouts, on up to three or four feet in diameter.

The method works satisfactorily in any soil that is quite firm. For the equipment will be needed the derrick, a rope of suitable length, a round plug of wood (for small diameter holes, a solid piece of log dressed down will be suitable) and some stiff wire.



The hole is first sunk, either with a large post hole auger, or by hand if the shaft is of some size. The sides should be smooth and the hole large enough to allow for the double thickness of the wall to still leave the desired inner space open. In shaping the plug, round both ends and turn in a screw eye to which the lower end of the rope is fastened. To hold the plug in the center of the hole, attach four stiff wires to the top so that the rounded portions rub the walls, but not tightly.

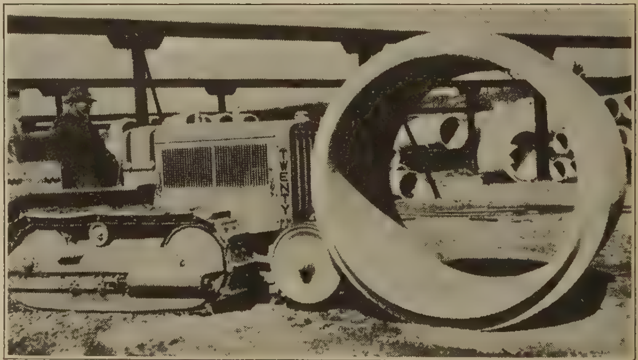
Concrete is dumped into the hole for the bottom. This will flatten out. Then drop in the plug until it rests upon the bottom. More concrete is shoveled in until the sides have been filled in up to the top of the plug. A flashlight will show easily how much to put it. This done, the plug is slowly raised its length and left for from 6 to 10 hours to let the first section harden. The plug is in position for the second section and this is shoveled in as was the first. This process is continued until the top of the hole has been reached. The result will be a concrete walled hole well finished and easily made.

The plan was used to line a cold air hole in a home cellar in which foodstuffs were kept during hot weather.

For the carriage, a large can which will slide up and down in the shaft, is ideal after one side has been cut away and shelves of tin discs soldered in place.

Tractor "Steers" Pipe

The Illinois-Wisconsin Concrete Pipe and Tile Company, of South Beloit, Illinois, have installed a pair of wheels on the front of a Caterpillar tractor so it may be used for "steering" finished concrete pipe.



The installation is so arranged that by means of a lever at the driver's right either wheel may be advanced or drawn back to "steer" the pipe. The flexibility of the Caterpillar tractor permits the placing of the pipe close together without additional men being needed.

Putting Over Something New

"Cal" Gochnauer Tells How He Introduced Light-Weight Concrete Block Into His Community

"For nearly a year we had been hearing of haydite. First, that the Best Block Company was making the unit. Then that Sorensons had taken it on at Racine. Salesmen told us about it and finally at our convention last year both Al Scheer and Julius Sorenson told us we had better investigate.

That investigation we proceeded to make. First—as to the reliability of the company handling the material and methods of sale of the material. We fight shy of any proposition where it is necessary to buy territory.

"Second: As to sales possibility. We talked with several of our leading contractors telling them of the product with a view of finding if the product appealed to them and if they would use it if we did go into its manufacture.

"Third: With relation to cost. We visited plants making the unit where we investigated the difficulties of manufacture. Gained some idea as to costs and determined what new equipment it would be necessary for us to purchase. The next step was to figure what our costs would be not forgetting that highly interesting item of overhead and including therein interest on additional investment and depreciation on additional machinery. This cost figure determined what our sales price could be. This sales price we compared with the cost of clay products with which we would be competing.

"Fourth: Confirmation. Which included a visit to our godfather, the Portland Cement Association, calling on Les Brodd in Milwaukee and going on to Chicago to see 'Billy' Allan. We knew that W. D. M. Allan would have the dope if anyone did. We also talked with Mr. Muehlstein, state building engineer, to get his slant on the product and to make sure there was no hitch there.

FEATHERWEIGHT
Haydite Building Units

are so light that even the smallest man can handle them all day without tiring.
See this ideal building unit being laid in the
APPLETON POST-CRESCENT MODEL HOME

GOCHNAUER
Concrete Products Co.
Appleton, Wisconsin

"So far so good. Our investigation showed us, however, that to compete with city clay products it was necessary to manufacture in the most economical manner. This meant new machinery and rebuilding a portion of our plant. We called in Jack Franklin and obtained figures with which we at once much refigured and revised our costs.

"The final step in the investigation was financial. It would be necessary for us to borrow money from the bank. We prepared a schedule showing just what each step in the manufacture cost. Showed how we obtained these figures and also prepared a schedule showing profits with varying sales. Then with a statement of our financial condition we called on the bank and found we could borrow the required money.

The model home in which Haydite light-weight aggregate was used; it is virtually a concrete home, the basement walls and partitions, the first floor, and the roof being concrete in one form or another

"We were then all set to make our connection with the Western Brick Company. The connection was made. The machinery was purchased and installed. From the first units made three were selected by a representative of the Portland Cement Association and passed a satisfactory test.

Introducing the New Product

"We were then already to go but how best to introduce the unit? Our thoughts turned first to the newspaper. We had been advertising our regular concrete block weekly but had never been happy over the fact that a good portion of the paper's circulation was of no value to us. With our extended territory made possible by the light weight of haydite we were now able to use all of the paper's circulation to advantage. The Appleton Trade Map shows our territory which contains a population of 200,000 and is very nearly covered by the Appleton Post-Crescent.

"Before we take up our advertising campaign we must go back a step. With this product or any other concrete product for that matter the architect is a most important

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A paper presented at the Wisconsin Concrete Products Association meeting at Milwaukee in January.

factor. The first architect called on was Earl Miller, (Earl, by the way, is a Rotarian). Earl was very much interested. In the course of the conversation he stated that he was just beginning plans for a model home for the Appleton Post-Crescent and that we had better see Horace Davis, business manager of the paper, and get him to use haydite units in that home. Horace (who by the way is a Rotarian also) was called on and was very much interested. After considerable investigation on his part it was decided to use haydite units for the exterior walls, with stucco and considerable stone trim for the exterior finish. (I mention the fact that these two men are Rotarians to emphasize the fact that such connections in this or similar organizations are very valuable in helping to put over anything.)

HAYDITE

(A light weight aggregate developed by Government Engineers during the war for use in making concrete ships.)

A Superior Lightweight Building Unit

The Gochnauer Concrete Products Co. announces that the NEW FEATHERWEIGHT HAYDITE BUILDING UNIT is manufactured and sold exclusively by them in New London, Seymour, Little Chute, Kimberly, Kaukauna, Neenah, Menasha, Oshkosh, Green Bay, Appleton and surrounding territory.

The New Unit Has an Appeal to the Architect, Owner and Contractor

TO THE ARCHITECT: because it combines in a masonry unit all desirable features of building materials.

TO THE OWNER: because of its permanence, low cost and very high INSULATION VALUE.

TO THE CONTRACTOR: because due to its light weight it is very easily handled; also because he can drive nails into it.

FIRE PROOF — SOUND PROOF — FROST PROOF — CONDENSATION PROOF—AGE PROOF—LIGHT WEIGHT WITH GREAT STRENGTH—NAILABLE — VERY HIGH INSULATION VALUE.

This new unit is to be used in the APPLETON POST - CRESCENT MODEL HOME. It is strictly an ABOVE GRADE unit. Investigate before you build anything.

GOCHNAUER
Concrete Products Co.
APPLETON, WISCONSIN

"This model home differs from most such ventures in that it is not being built of materials that could be obtained at the greatest discount or is it a catspaw to obtain a great amount of advertising. It is built to show the very latest and best in first class construction. The house is to cost about $50,000. It might well be called a 'Concrete Model Home' for the basement walls and partitions are concrete blocks; the exterior walls are haydite units and portland cement stucco; the first floor is concrete, the first story partitions are haydite units and the roof is covered with cement asbestos shingles. This photograph of the model home partially completed will give you some idea of it.

HAYDITE

Featherweight Building Units

Have been used by the following contractors in 19 buildings. ASK THEM!

August Beusch
Fraser Lumber & Mfg. Co.
Gruenke Bros. Const. Co.
Hegner Construction Co.
Fred Hoeppners Sons
Nicholas Kern
Max Konigseder
Fred H. Lillge, Jr.
Herman Ladwig
Robert Schultz
Piette Construction Co.
Greg Schindler
Harry Everts

Gochnauer Concrete Products Co.

Coal, Oil or Gas Cost Money

The INSULATION VALUE of the 8-inch Featherweight Haydite Building Unit is equal to that of 1 inch of Cork Board.

According to tests at Armour Institute it is twice as warm as clay tile, three times as warm as brick, five times as warm as concrete.

Its use in The Post-Crescent Model Home will save fuel money for years to come.

GOCHNAUER
CONCRETE PRODUCTS COMPANY

Newspaper advertising, to be effective, must reach the people who might be interested in it. So we have in our case a paper with just the right circulation. Our ad each week is on a prominent page in that paper and well displayed. This page is not one that is turned over hurriedly but is just chuck full of interesting reading matter. In this reading matter Haydite is frequently mentioned.

Now something about our ads. The first is a general announcement with a little too much in it possibly for a good ad but as this is the announcement of the model home as well as the first publicity on Haydite units it will get by. The second ad tells that the unit has the approval of Mr. Muehlstein, state building engineer, and of the Portland Cement Association; also some of the tests made on the unit. In the next issue we take a little less space and emphasize just one point about the unit and drive that home. The first of these stresses the light weight of the unit. The second is on fire resistance. The third is on economy of construction. The fourth meets a growing demand to know what Haydite is and is headed "What is Haydite?"

The fifth states that the Haydite unit has been used in 19 buildings at that time. Lists the contractors who have used the unit and invites the public to ask these men about it. The sixth is addressed to the people in the neighboring cities and states that on account of the light-weight of the unit very reasonable deliveries can be made in those towns. The seventh is addressed to the farmers. The eighth to the carpenters.

In the ninth we came back to earth. Here we call attention to the fact that the basement walls are our regular high test concrete block. The tenth is a recapitulation in a series of punches. Nailable, strong, light, fireproof, soundproof, frostproof, ageproof. The next two carry the season's greetings but with a punch. The final one to date is addressed to the architects.

"Once a week for six months the Post-Crescent will carry a page devoted to this home. This page has a very advantageous position and is mostly reading matter and cuts with but three or four ads one of which is ours.

"We believe that this campaign is going over in good shape. The 19 jobs mentioned in an ad a few weeks back have jumped to 27. Seven of these are complete houses the largest being a $75,000 job in which over 10,000 haydite units were used as back up for stone. Included in the list are stores, factories, warehouses and the like. However I dare say the indirect results far outweigh the direct. I venture to say that by the time the six months of the campaign are up that the only people in our territory who will not have flashed across their minds eye the word 'Haydite' when any building problem comes up will be the blind."

Trade Practice Conference on Reinforcing Industry

A trade practice conference for the concrete reinforcing steel industry is scheduled by the Federal Trade Commission to be held Thursday, April 18th, at Asheville, North Carolina. Commissioner G. S. Ferguson, Jr., will preside.

Applicants for this conference represent about 80 per cent of the concrete reinforcing steel industry on the basis of tonnage.

Among practices proposed for discussion at the conference are:

"Entering into contracts for large quantities of reinforcing steel bars without actual obligation of the buyer to purchase any particular quantity or quantities, or for any particular jobs, for the purpose of securing to the buyer a discriminatory price; splitting of fees, commissions, and other payments with engineers, architects and other persons, without the knowledge and consent of all parties to the contract; wilful interference with existing bona fide contracts; dumping surplus stocks in territory outside of distributors' regular markets, at discriminatory prices; failure of the distributors to adhere to their own published prices and submission of more than a single bid price on any one job, even though no changes in specifications have been made; secret rebates, commercial bribery and departure from terms of discount, and misbranding and misrepresentations in connection with the sale of bars.

Giant Precast Concrete Sewer Pipe

The United Pipe and Construction Company of Sacramento, California, recently constructed what is perhaps the largest precast concrete sewer ever made. The concrete sections are 9 feet in diameter, their size being realized by comparison with the man standing within the section in the foreground in the accompanying illustration.

Floor Finish Costs

In the report of a paper presented by John G. Ahlers and his associates, J. J. Lindon and M. F. Bird, at the American Concrete Institute convention, in the March issue, page 56, second paragraph, second column, an error was made in quoting the cost of test floor finishes by placing the decimal point one space too far to the right.

The costs should have been given as varying from $.076 to $.107.

From the Products Associations' Bulletins

Iowa Concrete Products Association

R. L. GAVIN, Secretary

BY way of the February issue of the "Concrete Products News" of this state association, it is learned that its members, while in convention recently, expressed themselves as being in favor of the association's continuance under its present form of organization and of assisting in the formation of a stronger national association.

It was decided also at this meeting that activity in 1929 would be concentrated on the Honor Roll for Quality Products. To this end a plan has been outlined and adopted. Its purposes, it is stated, is to create a greater confidence in concrete building units in the building industry and to stimulate interest and membership in the state association. To qualify the manufacturer for participation in the plan, products must pass periodic tests made on three representative samples by a local laboratory complying with the Hoover code. Upon receipt of test results those whose tests qualify them for the Honor Roll will appear monthly in the Products News.

Products manufacturers are urged to see that concrete products receive their rightful standing in any building code proposed or under revision. The help of the association secretary when necessary is offered.

Announcement of continuance of the Portland Cement Association's training school for concrete products salesmen is also made. As heretofore, salesmen will be equipped with test data and other technical information furnishing a good background for the reinforcement of sales arguments.

* * *

Wisconsin Concrete Products Association

JACK FRANKLIN, Secretary

STARTING in March, distribution of the popular weekly letter was resumed. It is forecast that they will be of a more personal nature than those of previous years in that they will tell how concrete products manufacturers and business men in other industries have increased their business and the quality of products without additional cost of the product.

Examination of the initial issue indicates that it covers the 1929 association program. It goes into some detail regarding the effect the activities of the newly acquired field engineer will have on the prosperity of the individual plant. The time of this engineer will be devoted to calling on prospective users of concrete products, architects, contractors, etc.

Another step that will be taken to promote the use of concrete products is a direct-mail campaign tying up with that of the Portland Cement Association, the letter states. The first of six circulars which are a part of the campaign will make its appearance in April.

Another matter on which some thought is being devoted is the selection and adoption of a trade name and trade mark for all products made by members of the Wisconsin association.

An especially pungent paragraph or two appears in the February issue of the association's monthly "Digest," under the title, "Sell Your Product and Not Your Competitor," to the effect that even a poor salesman can sell when and where competition is low, but that it takes a good man to sell when it is high.

To continue, "Keep in mind that a natural psychological trait works against you when you criticize a competitor. When the average salesman approaches the average buyer the latter goes on the defensive. Now, the moment that salesman undertakes to find fault with a competitor, the buyer immediately, even though unconsciously, takes the side of the competitor who is being criticized. He is selling the competitor's product.

"There are many buyers who take keen delight in getting a salesman, especially a younger salesman, into a state of excitement by telling him something or other that a competitor is supposed to have said or done. Many buyers feel that they can get better prices or terms from a salesman by talking to him about his competitor, and the competitor's product."

* * *

Nebraska Concrete Products Association

ROGER MERRITT, Secretary

EVIDENTLY one of the most important and interesting subjects to the manufacturer brought up at the recent annual meeting, as reported in the February news letter, was the subject of cost accounting, by A. V. Johnson. The paper as presented appears in this issue of the bulletin and to those interested in the exhibits of cost accounting sheets, it is suggested they secure copies from the author.

The January issue of the letter reports that the Nebraska products industry had a successful year during 1928, with a comfortable gain over the previous year.

* * *

Northwest Concrete Products Association

F. R. ZAUGG, Secretary

MEMBERS of the Northwest group are warned of the necessity for the bearing down on selling efforts with the seasonal rise in temperature. "Even though the plant may be run to capacity, an extra night shift will help tremendously to catch up. The selling must go on, especially during the spring months. The results will carry over into the fall, and the efforts put forth now will have a large effect at that later time. The concrete products business should not be seasonal, as there is always an outlet for some kinds of articles regardless of weather conditions."

Following a visit at Ontario, Idaho, the executive secretary tells of the pleasant office occupied by a products manufacturer at that town. The structure is located on a corner and concrete masonry is used as far as possible. The exterior finish is colored concrete brick and red roofing tile. The interior is of cement stucco, while the floor is laid up of colored concrete tile.

An instance of the employment of cast stone for interior decoration also appears in this bulletin. It concerns investment brokers' offices occupying the entire second floor of a new building at Seattle. The beautiful cast stone arch visible from the elevator vestibule is the first of a series of similar units in the elaborately furnished offices. The arches are a product of the Pacific Stone Company.

A paragraph entitled "Midsummer Meeting" announces that this event will be held at Shelton, Wash.

High Early Strength Concrete

An Analysis of Methods and Costs of Producing High Early Strength Concrete, Using Both Standard and Special Cements

By EDWARD E. BAUER
Instructor in Civil Engineering, University of Illinois, Urbana, Ill.

CONCRETE is a material which develops strength with age. The amount of strength acquired in any given period of time depends upon a number of factors to be discussed in this paper. In the early days concrete did not gain strength rapidly and it was found necessary to wait 28 days after making it before testing. Because of this practice of testing at 28 days, it was generally considered necessary to wait 28 days before using the concrete. During recent years tests have been made on concrete at ages earlier than 28 days so that it is possible now to use concrete structures sooner than was customary previously.

The idea of waiting 28 days before using concrete became so firmly fixed that great surprise and often alarm is expressed at the early use of concrete structures. Better materials and practices together with increased knowledge have made possible the use of concrete structures as early as 2 to 5 days after placing the concrete. Testing of specimens made from the concrete being used on any job is a good way to determine when the structure is ready to use.

It is the purpose of the writer in this paper to discuss briefly the factors which affect the rate of hardening of concrete and to present certain data bearing on this subject which he has secured during the past year.

Factors Affecting Strength

The rate at which concrete gains strength depends upon the following factors:

(1) Kind of cement
(2) Water-cement ratio
(3) Temperature
(4) Admixtures
(5) Curing
(6) Time of mixing

These factors are so interrelated that there must necessarily be some overlapping and repetition in the discussions of each.

Kind of Cement

Practically all of the cement sold in the United States is known as portland cement and is made to meet the minimum requirements of the standard specifications of the American Society for Testing Materials. Portland cement is defined by that specification to be "the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum."[1] The cements that are made in the usual way and conform to this definition in every respect will be designated in this paper as standard portland cements. Other cements which are made in almost the same manner but which develop higher early strengths will be called special or high early-strength cements.

Standard Portland Cements

Other things remaining constant the rate at which concrete gains strength is a function of the ratio of water to cement. Concretes with the lower water-cement ratios develop strength at a more rapid rate than do those with the higher water-cement ratios. When usable early strengths are desired, those strengths may be secured with the standard brands of portland cement by using proportions of dry materials which will permit the use of the desired water-cement ratio.

In Table 1 and Fig. 1 are given what may be termed basic time-strength relationships for water-cement ratios varying from 7½ gal. of mixing water per sack of cement to 4 gal. per sack and for ages varying from 1 to 28 days. The strengths for the various water-cement ratios at 28 days are based on the original Abrams' curve

$$S = \frac{14{,}000}{7^x}$$

in which S is the compressive strength at 28 days in lbs. per sq. in. and x is the water-cement ratio (direct ratio: not gallons per sack of cement).[2] It should be remembered that this curve is based on laboratory tests made about 1915 and that the curing temperature was 70 deg. F. The manufacturers have made marked improvements in the quality of their cements in the past 15 years. The American Society for Testing Materials has raised the minimum strength requirements as rapidly as the manufacturers generally were able to meet them. Changes in the specifications were made in 1916 and 1926. Manufacturers as a rule are endeavoring to make the best cement possible and are not just trying to meet the minimum requirements of the standard specifications.

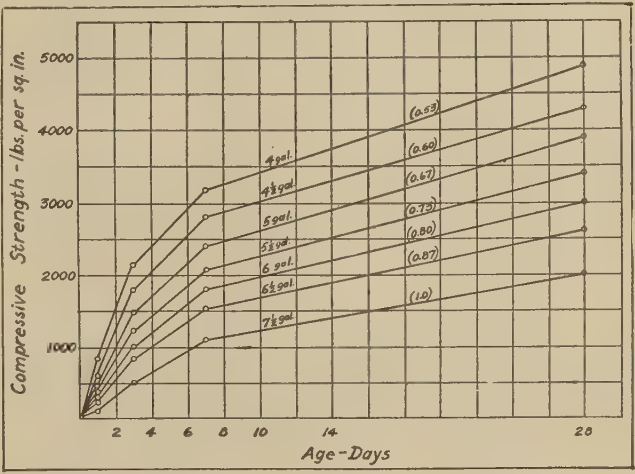

Fig. 1—Basic relationships between age and compressive strength for various water-cement ratios
(Data shown in Table 1.)

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[1] A.S.T.M. Standards, 1927, Part II, p. 23.

[2] Abrams, *Design of Concrete Mixtures*, Bulletin 1, Lewis Institute.

TABLE 1—BASIC STRENGTHS USING STANDARD PORTLAND CEMENT*

		Compressive Strength, lbs. per sq. in. (cured wet until test)				Typical Mixes (illustrating range for a particular set of aggregates)		
Reference No.	Water-Cement Ratio, gal. per sack	1 day	3 days	7 days	28 days	Slump, in.	Mix	Cement, bbl. per cu. yd.
1	7½	100	500	1100	2000	6-7	1:2:3½	1.40
2	6½	230	830	1530	2600	2-4	1:2:3½	1.40
3	6	300	1000	1800	3000	½	1:2:3½	1.40
4	6	300	1000	1800	3000	6-7	1:1½:3	1.65
5	5½	370	1230	2070	3400	2-4	1:1½:3	1.65
6	5	470	1500	2400	3900	½	1:1½:3	1.65
7	5	470	1500	2400	3900	6-7	1:1:2	2.25
8	4½	600	1800	2800	4300	2-4	1:1:2	2.25
9	4	830	2130	3170	4900	½	1:1:2	2.25

*From pamphlet "High Early Strength Concrete," published by the Portland Cement Association.

One of the methods of improving the strength-developing properties of cement has been to increase the fineness of grinding. Increased fineness of grinding has been most beneficial in producing higher early strengths. Manufacturers have also put forth special efforts to secure more uniformity in the mixture of the raw materials with the result that there is not so much variation in the product of any of the plants nor from plant to plant.

When clean and structurally sound aggregates are used and when the principles of good concrete practice are followed, it is reasonable to expect that the strengths indicated in Table 1 *may be secured with any of the standard brands of portland cements, except when the temperature of the concrete goes below* 50 *deg. F.* In the summer time when air temperatures are high it is possible to secure much higher strengths than those shown. On pavement construction work in the summer the writer has secured with approximately 6 gal. of mixing water the same strength as shown in the table for 4 gal.

The curves indicate the rate at which concrete gains strength for 70 deg. F. curing. When the temperatures are higher the strength increases at a more rapid rate as will be shown later on. The probable 28-day strengths may be fairly closely estimated by means of Fig. 1 from the strengths at earlier ages.

In Table 2 and Fig. 2 are shown the results of some tests by the writer to give the relationship between age and strength for 2 of the more common mixes and water-cement ratios. For each proportion 4 different cements were used. The concrete was machine mixed, molded, cured and tested in the standard manner. The aggregates used were fairly coarse, which accounts for the small water-cement ratio with the 1:2:3 mix and for the large amount of slump secured for the 1:2:4 mix and the water-cement ratio of 1.

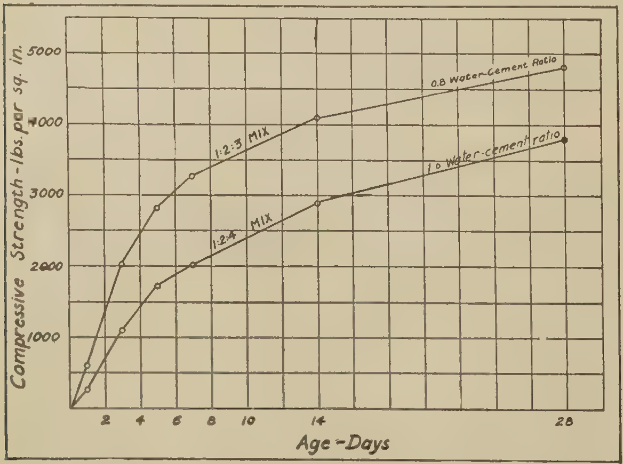

Fig. 2—Relationship between age and compressive strength for two common mixes and water-cement ratios
(Data shown in Table 2.)

TABLE 2—RELATIONSHIP BETWEEN AGE AND COMPRESSIVE STRENGTH FOR STANDARD PORTLAND CEMENTS AND TWO PROPORTIONS

(Laboratory Tests)
VALUES IN LB. PER SQ. IN.

	Proportion, 1:2:3 Water-Cement Ratio, 0.8 Slump, 3½ in.					Proportion, 1:2:4 Water-Cement Ratio, 1.0 Slump, 9 in.				
Age, days	1	2	3	4	Ave.	1	2	3	4	Ave.
1	460	755	775	340	575	290	200	175	305	240
3	1910	2415	1830	1850	2000	1190	975	985	1240	1100
5	2950	2870	2770	2615	2800	1720	1665	1555	1875	1705
7	3580	3375	3110	2985	3260	1980	1765	1980	2340	2015
14	4280	4370	3780	3870	4075	3175	2475	2680	3155	2870
28	5000	4610	4850	4750	4800	4100	3700	3600	3900	3825

Each value in this table is the average result for three 6 x 12-in. cylinders.

Beam Strengths

In Table 3 are given some beam strengths for the 1:2:3 mix concretes of Table 2. At the times the cylinders were made, beams were cast and cured in the same manner as the cylinders. The average curve is plotted in Fig. 3.

In Table 4 are given the results of some tests on field-made specimens, cast during the summer of 1927 with concrete being used in the city pavements at Champaign, Illinois. These beams were left on the job for 24 hours and then placed in a moist room until tested. The unusually high 2-day value for number 5 may be due entirely to the high air temperatures prevailing at that time and the lower 2-day value for number 6 to the lower air temperatures at that time. The average curve is shown in Fig. 3.

TABLE 3—RELATIONSHIP BETWEEN AGE AND BEAM STRENGTH

Standard cements
Laboratory made specimens
Mix: 1:2:3 by volume
Water-cement ratio = 0.8
Moist-room curing at 70 deg. F.

MODULI OF RUPTURE IN LB. PER SQ. IN.

Age, days	1	2	3	4	Average
1	—	—	165	150	160
3	475	380	425	425	425
5	615	535	605	675	605
7	735	585	695	815	705
14	765	795	770	835	790
28	810	825	950	905	870

Each value in this table is the average result of 3 breaks.

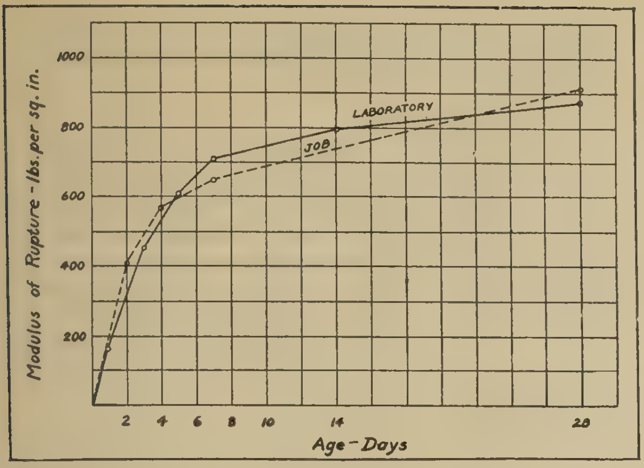

Fig. 3—Relationship between age and beam strength for a 1:2:3 mix and an 0.8 water-content ratio
(Data shown in Tables 3 and 4.)

TABLE 4—RELATIONSHIP BETWEEN AGE AND BEAM STRENGTH

Standard cements
Field specimens
Mix: 1:2:3 by volume
Moist-room curing

MODULI OF RUPTURE IN LB. PER SQ. IN.

Age, days	1	2	3	4	5	6	Average
2	435	375	355	380	520	320	400
4	595	540	515	525	650	565	565
7	600	620	645	660	665	685	645
28	885	895	——	900	955	920	910

Each value in this table is the average of 2 or 3 breaks.

Special Cements

During the past few years a number of American manufacturers have been producing special cements to develop higher earlier strengths than were possible with the standard brands. Not much is known concerning the exact method of manufacturing, except for one of them. In making this particular brand, the raw materials used in manufacturing standard portland cement are prepared and burned in the usual way. After the first grinding of the clinker it is put through the kiln again, after which it is ground in the usual manner. This gives the clinker an extra grinding and burning. The manufacturer guarantees that at least 90 per cent will pass through a 200-mesh sieve.

It should be remembered that these special cements are comparatively new and that experience with them is limited. At the present time the manufacturers are about as familiar with their product as any one, so that it seems logical to follow rather closely their recommendations. The same rules of good practice should be followed in using these cements as would be observed with the standard cements. The writer's experience with these cements is that they do develop much higher early strengths than do the standard brands for the same water-cement ratios and conditions of making, placing and curing. The time-strength curves for these cements are different, which makes it impossible to secure average curves for this type of cement.

In Table 5 are given the results of some laboratory and field tests on concrete in which several of the special cements were used. All of the mixtures were a 1:2:3 by volume. In the laboratory tests the water-cement ratio was held at 0.8 (6 gal. of mixing water per sack of cement). The field concrete had about the same water-cement ratio since similar materials were used in both cases. Values in the table for the field tests are for 1 cylinder each and for the laboratory tests 3 cylinders. Curves for the 1928 values are plotted in Fig. 4. A brief explanation will be given for each column in Table 5:

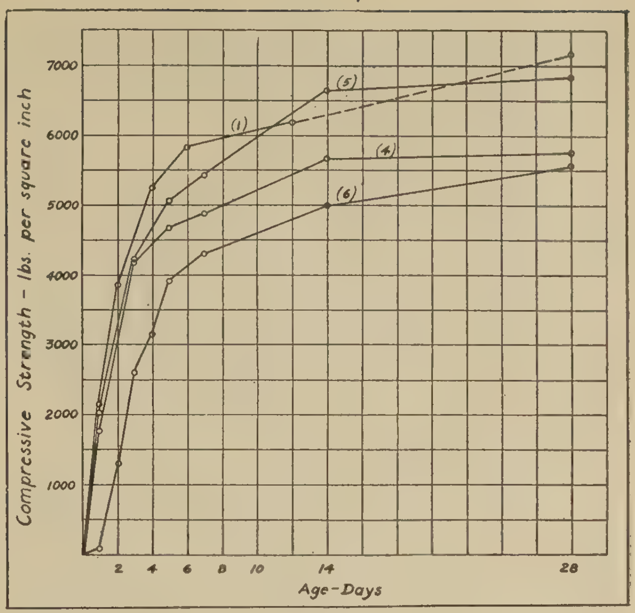

Fig. 4—Relationship between age and compressive strength for concrete with special cements
(Data shown in Table 5.)

TABLE 5—RELATIONSHIP BETWEEN AGE AND COMPRESSIVE STRENGTH

Special cements
Field and laboratory specimens
Mix: 1:2:3 by volume
Water-cement ratio = 0.8

COMPRESSIVE STRENGTHS IN LB. PER SQ. IN.

	Field Test	Laboratory Tests				Field Test Low Temperatures
		1927		1928		
Age, days	1	2	3	4	5	6
1	1770	1010	1000	2015	2145	——
2	3855	——	——	——	——	1310
3	——	3620	3400	4165	4225	2600
4	5240	——	——	——	——	3160
5	——	4475	4140	4655	5055	3930
6	5820	——	——	——	——	——
7	——	4870	4520	4895	5435	4300
13	6190	——	——	——	——	——
14		5220	5230	5655	6645	5000
28	*	5360	5510	5750	6825	5550

*Specimen failed to break at 7250 lb. per sq. in. At 40 days same cylinder took a load of 7670 lb. per sq. in.

Column 1—Cylinders were made September 2, 1928, at Champaign, Illinois, from concrete being used in paving work. The concrete was mixed at a central plant and hauled about 1¼ miles before the cylinders were made. Cylinders were cured in a moist room at 70 deg. F. until tested.

Columns 2 *and* 3—Cylinders were made in the laboratory in the fall of 1927. Cement for columns 1 and 3 are the same. The concrete was mixed in a tilting drum mixer, molded, cured and tested in the standard way.

Columns 4 *and* 5—Cylinders were made in the laboratory in the fall of 1928. Cement for columns 2 and 4, and for 3 and 5 are the same. Proportions, mixing, molding, curing, and testing were same both years. Apparently during the year considerable improvement was made by the manufacturers in the ability of the cement to develop higher early strengths, the 1-day strengths in 1928 being about double those for 1927.

Column 6—Some of the same cement used for the concrete in column 4 was used by one of the Champaign contractors in building a driveway. The mix was 1:2:3 by volume. The same materials were used as for the regular paving work. The concrete was placed on November 10, 1928, while the air temperature was about 37 deg. F. Temperatures during the first night fell a few degrees below freezing but it is doubtful whether the cylinders froze. The cylinders remained out in the open with the forms removed all the time until tested.

Cost of Special Cements

These special high early strength cements sell for about $1.00 to $1.50 more per barrel than do the standard brands. For a cement content of 1.5 barrels per cu. yd. of concrete, the extra cost for this cement would be between $1.50 and $2.25 per cu. yd. For pavement 7 in. thick the extra cost for cement would be between 30 and 45 cents a sq. yd. The same amount of money spent on additional standard cement will produce about the same results.

Effect of Water-Cement Ratio

As pointed out before, concretes with the lower water-cement ratios develop higher strengths than do those with the high ratios. This holds true at all ages, so that if high or usable strengths are necessary at an early age, they may be secured through the use of concrete with the proper water-cement ratio. The special cements come under this rule as well as the standard brands. With the special cements the water-cement ratios need not be as small as with the standard brands to secure the same strength at the same ages.

On much of the work today the old practice still prevails of specifying the proportions of dry materials with no mention of the amount of water to be used. The wetter concretes do not gain strength as rapidly as the drier ones, nor do they gain as much. In Table 1 are given basic strengths for 3 consistencies for each of 3 different mixes. *It should be noted that in every instance the concretes with the lower slump values (drier concrete) develop higher strengths at all ages than do the ones with the high slump values.*

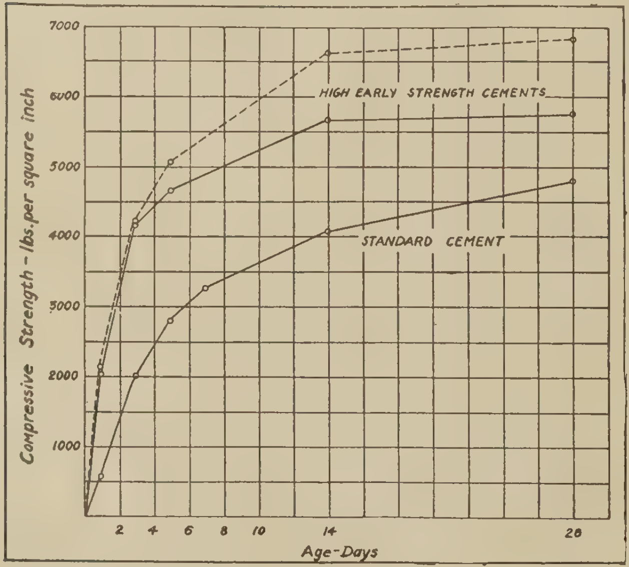

Fig. 5—Relationship between age and compressive strength for concretes made with special and standard cements

(Data for curves labeled *High Early Strength Cements* are shown in columns 4 and 5 in Table 5. Data for curve labeled *Standard Cement* are shown in Table 2, cement number 4 under 1:2:3 proportion.)

In order to use the smaller water-cement ratios necessary for high early strength the amount of aggregates that can be used with each bag of cement must be reduced. The amount of the reduction will depend upon the water-cement ratio and the gradation and maximum size of the aggregate. The best proportions to use for any water-cement ratio and given materials may be most easily determined with a few trial batches.

Effect of Temperature

The rate at which a given concrete gains strength is a function of the temperature of the concrete and its age. At temperatures above freezing and below approximately 150 deg. F. higher strengths are developed for the higher temperatures. Concrete which is frozen does not gain any strength. Apparently there is a temperature between 100 and 200 deg. F. for which a maximum effect is secured. Sufficient test data are not available yet for us to know just where this critical point comes and what factors affect it. Strengths are developed at a more rapid rate for any temperature at the early ages than at the later ones.

In Table 6 and Fig. 6 are given the results of a series of tests to determine the effect of the temperature of the concrete on the strengths developed. All the concrete was machine mixed in the laboratory at 70 deg. F. The cylinders remained in the forms for 24 hours, at the end of which time they were placed in their respective curing temperatures.

One set was placed in a refrigerator which was maintained at approximately 5 deg. F. *These cylinders gained no strength while frozen.* Cylinders were thawed out before testing.

Another set was placed in a refrigerator maintained between 32 and 40 deg. F. At no time were these cylinders frozen. Even though the temperature was just above freezing the concrete developed a fair amount of strength.

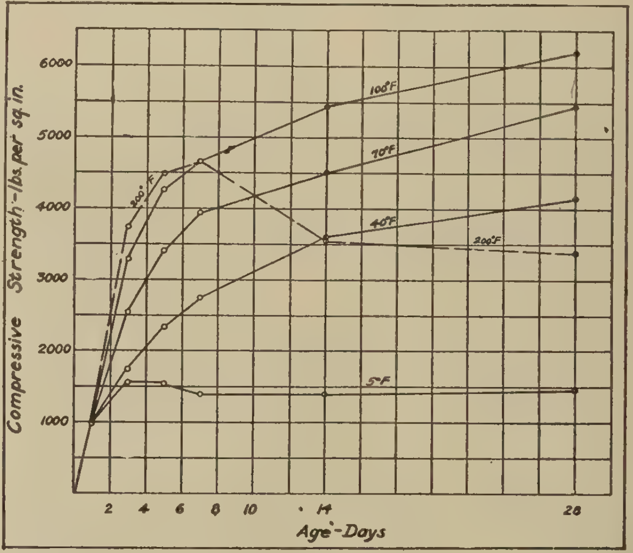

Fig. 6—Relationship between age and compressive strength for concrete cured at various temperatures

All concrete was made and cured for 1 day at a temperature of 70 deg. F. (Data shown in Table 6.)

The third set was cured in the standard way, in a moist room at 70 deg. F. This is the basic or normal curve.

A fourth set was kept in water at 100 deg. F. These cylinders show a greater amount of strength at all ages.

The fifth set was placed in live steam taken directly from the university main. The temperature of the concrete was probably about 200 deg. F. Concrete materials or the concrete itself is often heated during cold weather and it was the purpose of this set to check the effect of the high temperatures on the strength of the concrete. The strengths up to 7 days were good but after that there was a serious retrogression which indicates that care must be exercised not to heat the concrete to high temperatures.

TABLE 6—COMPARISON OF THE RATES OF GAINING STRENGTH OF CONCRETE CURED AT VARIOUS TEMPERATURES*

Standard portland cement
Laboratory specimens
Mix: 1:2:3 by volume
Water-cement ratio = 0.8

COMPRESSIVE STRENGTHS IN LB. PER SQ. IN.

	Curing Temperatures				
Age, days	5 deg. F.	40 Deg. F.	70 deg. F.	100 deg. F.	200 deg. F.
1	-------	-------	1005	-------	-------
3	1555	1740	2530	3280	3730
5	1545	2335	3410	4260	4470
7	1395	2730	3940	4650	4670
14	1415	3600	4520	5440	3650
28	1460	4140	5440	6200	3370
49	-------	-------	-------	-------	3430

Each value in this table is the average result for 3 cylinders.

Check tests were run to make sure no mistake had been made.

From the first set of cylinders it is quite evident that concrete does not gain strength while frozen. If the concrete had been frozen before the cement had set, the concrete would not have developed any strength. Concrete that has had an opportunity to secure some strength before freezing will continue to gain strength again once it is thawed out. Freezing at early ages does more harm than at later ages. For the richer mixes the time the concrete should be protected from freezing may be less than for the leaner ones.

TABLE 7—RELATIONSHIP BETWEEN AGE AND COMPRESSIVE STRENGTH

Standard portland cements
Field specimens
Mix: variable

COMPRESSIVE STRENGTHS IN LB. PER SQ. IN.

	1:2:3 Mix			1:1½:2½ Mix	
Age	1	2	3	4	5
1 day	1025	885	100	1800	635
43½ hours	-------	-------	-------	2845	-------
2 days	1945	1800	425	-------	2080
56 hours	-------	-------	-------	-------	2720
3 days	-------	-------	845	3735	-------
4 days	2710	2660	1380	-------	3180
5 days	-------	-------	1800	4490	-------
7 days	3960	3220	2510	4490	4030
14 days	4520	4520	3150	5650	4700
28 days	5515	5015	4170	6250	5580

Each value in this table is for 1 cylinder.

*From Bauer, *Plain Concrete*, p. 173.

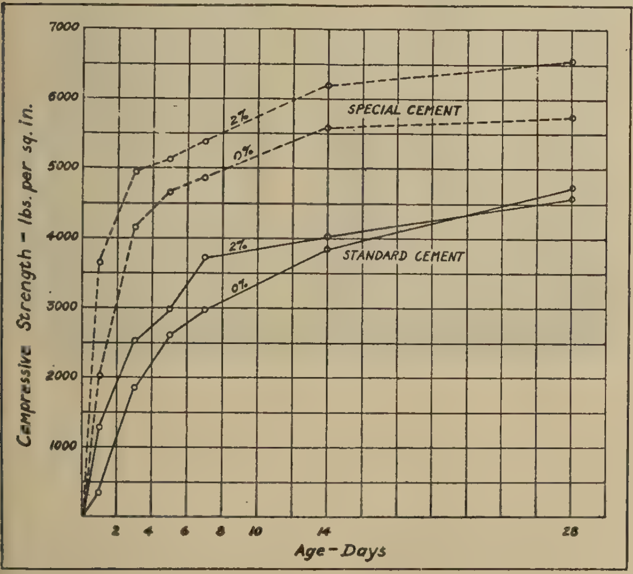

Fig. 7—Relationship between age and compressive strength for concretes made with standard and special cements and with and without calcium chloride as an admixture

(Data shown in Table 8.)

In Table 7 are given the results of some field tests in which the temperature of the concrete varied. All of the concrete was made by the same contractor and was used in street paving work in Champaign or Urbana, Illinois.

Cylinders whose results are given in column 3 were molded on November 12, 1928. The air temperature was just above freezing during that day. The cylinders were kept out in the open all the time until tested. There is a marked reduction in strength due to the lower temperatures.

A richer mix was used on one of the intersections in order to permit its use at an earlier date. Results from two series of cylinders are given in columns 4 and 5. The first set was made on October 15, 1928, when the air temperatures were well above freezing. The second set was made on October 18, 1928, when the air temperatures were just above freezing. Air temperatures at night for a few nights were below freezing. Again there is an appreciable lowering of the strength due to lower temperatures. The 1:1½:2½ mix required about 1 1/3 sacks more of cement per cu. yd. than did the 1:2:3 mix.

The cylinders whose results are given in the first two columns were molded on September 1, 1928. In one case the mixer was operating on the subgrade and in the other the concrete was being hauled about 1¼ miles from a central mixing plant. Cylinders were cured in the moist room at 70 deg. F. These values are slightly higher than those in Table 2 for the laboratory made cylinders of the same proportions.

Effect of Calcium Chloride

Calcium chloride is being used now to some extent as an integral curing agent and also for the purpose of lowering the freezing point of the mixing water in cold weather. Recent tests by the Bureau of Public Roads[1] indicate that at 28 days the strength of the concrete cured with calcium chloride in the mixing water is as great as when cured with water in the usual way. If the same effect can be secured by using calcium chloride in the mixing water as by water curing, a curing problem in connection with early strength concrete will have been solved. A certain amount of strength is added by moist curing during the first few days. How can concrete be cured by any one of the usual methods after it is put into service? Strengths are often sufficient at the end of 1 or 2 days to permit partial or even full use of the concrete.

Different cements react differently with calcium chloride so that it is not possible to say that any certain amount of calcium chloride will produce the maximum effect for all brands. Two per cent (generally taken as 2 lbs. per sack of cement) is recommended as a safe amount to use. Greater amounts should only be used when tests indicate that a greater effect can be secured. It should not be concluded that because higher strengths can be secured using calcium chloride with one special cement that the same effect can be obtained with all special cements.

In Table 8 are given the results of tests conducted by the writer in the fall of 1928 to secure time-strength relationships for various percentages of calcium chloride in a paving mixture. One standard and one high early strength cement were used.

Sets of 18 cylinders were made with 2 and 4 per cent of calcium chloride and placed in the moist room at the end of 24 hr. Similar sets were also made with 2, 3 and 4 per cent calcium chloride and placed in the laboratory air. With 2 per cent of calcium chloride incorporated moist curing has no additional effect in developing strength. The 28-day strengths are about the same for moist curing with or without calcium chloride and for the dry curing with the admixture. The greatest gain in strength due to calcium chloride is at one day and the effect gradually lessens until there is no effect at 28 days.

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[1] See paper by Jackson and Werner, "Field Experiments in the Curing of Pavements," in *Public Roads*, September, 1928.

In columns 7 and 8 are given the results of tests to show the effect with a special cement. There is a very marked increase in strength at one day for this cement, 2 per cent of calcium chloride producing 3640 lb. per sq. in. as compared to 2015 without the chloride. The 28-day strength with the calcium chloride is also greater than without it, but the amount is materially reduced.

TABLE 8—RELATIONSHIP BETWEEN AGE AND COMPRESSIVE STRENGTH

Standard and special cements
With and without calcium chloride admixture
Laboratory specimens
Mix: 1:2:3 by volume
Water-cement ratio = 0.8

COMPRESSIVE STRENGTHS IN LB. PER SQ. IN.

	Standard Cement						Special Cement	
	Moist Curing			Dry Curing			Dry Curing	
	Percentage of Calcium Chloride							
	0	2	4	2	3	4	0	2
Age, days	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	340	1195	1185	1260	1095	920	2015	3640
3	1850	2565	2615	2530	2615	2075	4165	4950
5	2615	3065	3065	2995	3145	2345	4655	5130
7	2985	3395	3205	3715	3655	2825	4895	5385
14	3870	4170	4065	4050	4330	3470	5655	6220
28	4750	4730	4700	4590	4600	4000	5750	6550

Each value in this table is the average result for 3 cylinders.

Unless the rate of evaporation of the mixing water out of the concrete during the first week is unusually high, moist curing has effect on the early strength of the concrete. The effect of the omission of moist curing becomes noticeable as a rule at about 28 days and becomes greater as the age of the concrete increases.

Curing should not be omitted even though the strength tests indicate good quality concrete at the early ages. In the case of the pavements, the surface layer dries out first and also receives all of the effect of traffic. Test cylinders or beams are not a measure of the quality of that surface layer unless that surface layer is kept wet, the same as the portion underneath.

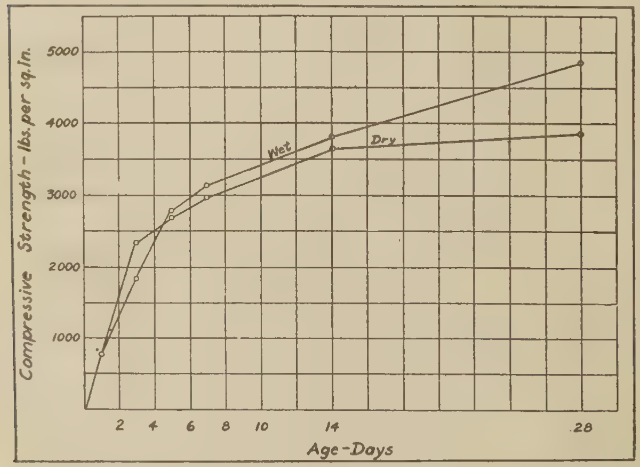


Fig. 8—Relationship between age and compressive strength for concrete cured moist and dry

The curves in Fig. 8 show the results for concrete which has been cured with and without moisture. The proportions were 1:2:3 by volume and the concrete was machine mixed in the laboratory.

Increasing the time of mixing is generally assumed to increase the early strength of the concrete more than its later strength. Just how much reliance in this connection can be placed on present day mixers is rather uncertain—too uncertain to be counted upon.

10,000 Miles of Federal Aid Highways Improved in 1928

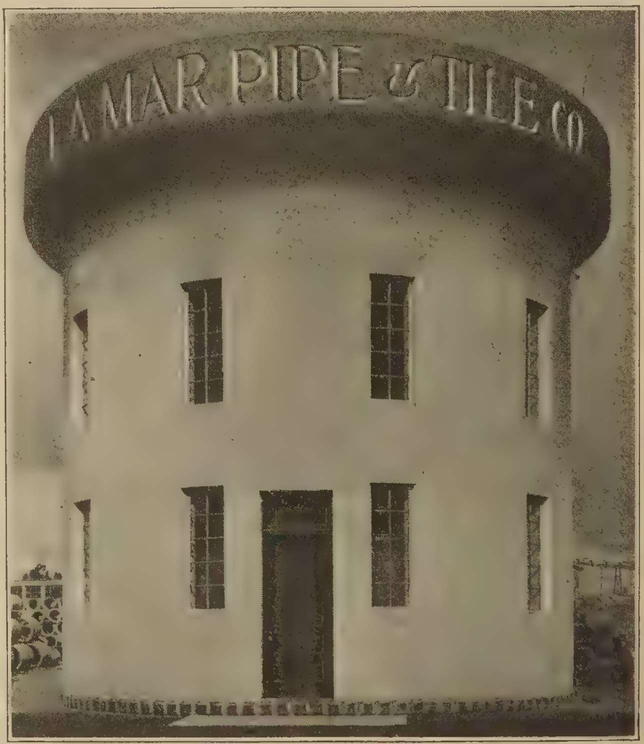
A total of 9,753 miles of federal-aid highways were improved in the calendar year ending December 31, 1928, by the 48 state highway departments and that of Hawaii, in co-operation with the Bureau of Public Roads of the United States Department of Agriculture. Of that total, according to figures compiled by the bureau, 7,625 miles had not previously been improved with federal aid, while 2,128 miles which had already been so improved were brought to higher stages of construction. These figures bring the total mileage improved with federal aid, as of December 31, to 76,075 miles. In the federal-aid system are a total of 188,017 miles.

At the end of December, 9,216 miles of federal-aid roads were under construction and 1,597 miles were approved for construction.

Giant Pipe Is Products Company's Office Building

Hailed as the largest concrete pipe office in the world, the administration building of the Lamar Pipe and Tile Company at Grand Rapids, Michigan, is in fact a concrete pipe building.

The structure is 24 ft. inside diameter and 30 ft. to top of bell of pipe, being built on the scale of a 24 in. plain, bell end, sewer pipe. Concrete building tile, size 5 by 8 by 12 in., were used in the wall construction, being laid crosswise to give a 12 in. wall. Four by 5 by 12 in. concrete tile were used for inside partitions. Floors and stairs are of reinforced concrete.



Three coats of portland cement stucco were used for the outside wall finish, the final coat being of white cement. The interior finish of the walls is of portland cement stucco, the final coat being a cream color mixed in the mortar. Steel window frames were installed and inside woodwork is of oak trim.

Reinforced Concrete Design Simplified

Chart K—Area of Steel in T-Beams

By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

Joint Committee Specifications

$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$n = 15$

$$A_s = \frac{M}{18{,}000\,(d - t/2)}$$

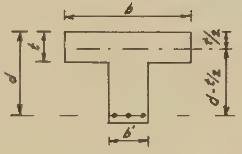


CHART K is a three variable nomograph solving the equation

$$A_s = \frac{M}{18{,}000\,(d - t/2)}$$

This is an approximation, the logic for which will be demonstrated later in the discussion.

T-Beam Design

In modern reinforced concrete construction the floor slab is usually poured monolithic with the supporting beams. It seems reasonable to assume that the floor slab adds some stiffness to the supporting members. When properly tied together, a portion of the floor slab and the beam constitute what is known as a T-beam. That portion of the floor slab, Fig. 1-K, assumed as acting with the beam is called the "flange." The supporting beam, below the slab, is called the "stem," or "web." The amount of slab assumed as acting with the beam is arbitrarily fixed by specification or code. The Joint Committee specifies:

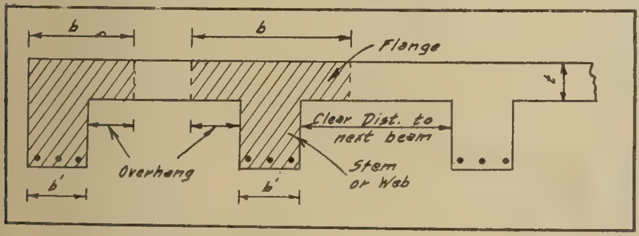


Figure 1-K

"Effective and adequate bond and shear resistance shall be provided in beam-and-slab construction at the junction of the beam and slab; the slab shall be built and considered an integral part of the beam; the effective flange width to be used in the design of symmetrical T-beams shall not exceed one-fourth of the span length of the beam, and its overhanging width on either side of the web shall not exceed eight times the thickness of the slab nor one-half the clear distance to the next beam.

"For beams having a flange on one side only, the effective flange width to be used in design shall not exceed one-tenth of the span length of the beam, and its overhanging width from the face of the web shall not exceed six times the thickness of the slab nor one-half the clear distance to the next beam.

"Isolated beams in which the T-form is used only for the purpose of providing additional compression area, shall have a flange thickness not less than one-half the width of the web and a total flange width not more than four times the web thickness."

As seen from the above specifications, there are in general two classes of T-beam:

(1) Beam-and-slab construction, in which the slab adds to the strength of the beam.

(2) Isolated beams, in which the T-form is used to economically provide additional compression area.

Example

Required a beam-and-slab design for the following conditions:

Live-load, 150 lbs. per sq. ft.
Slab, supported on two sides, with a simple span of 12 ft.
Beams, with simple span of 20 ft.
$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
From Chart I,

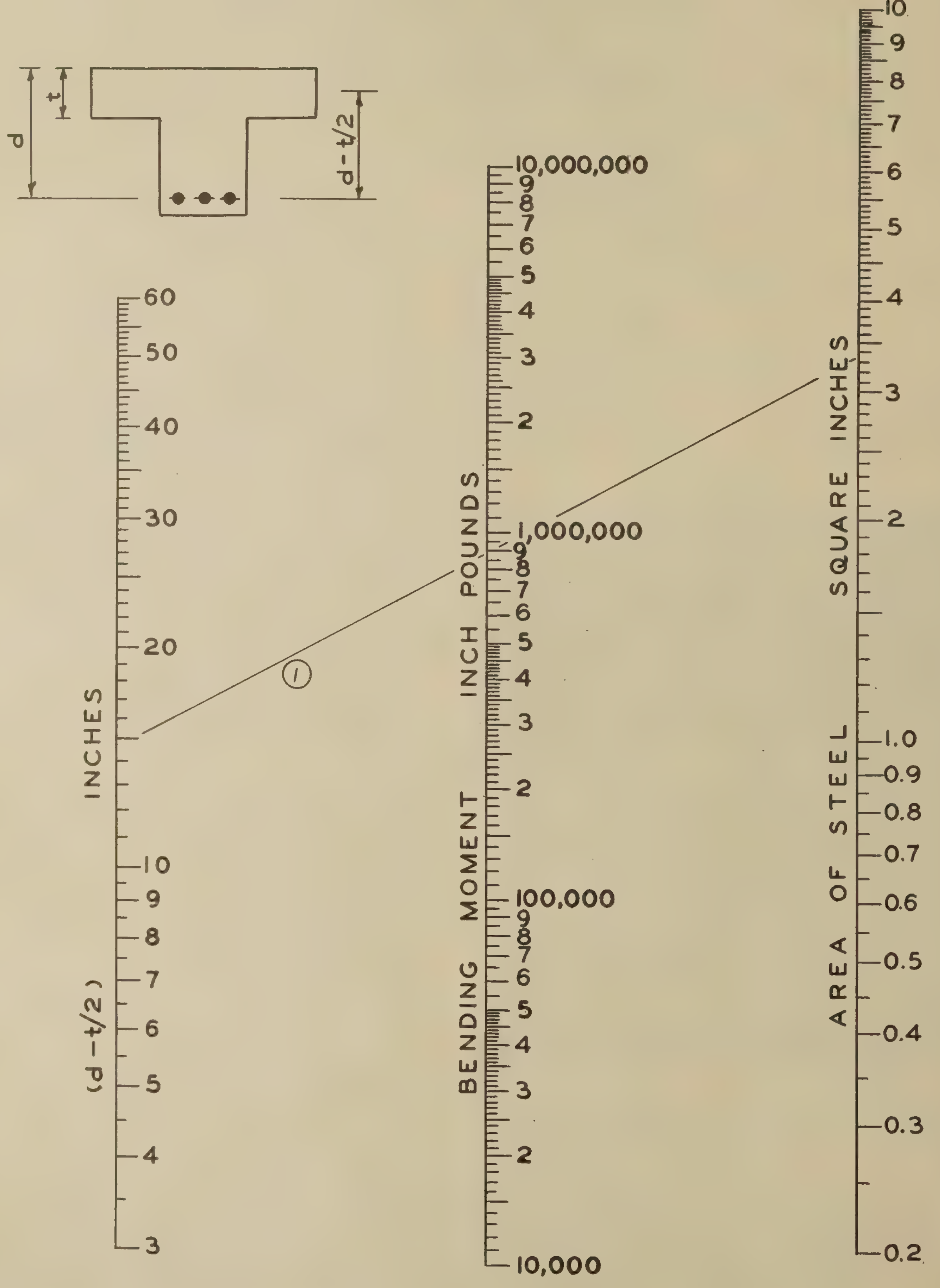
Given { Live Load = 150 lbs. per sq. ft.
Simple Span = 12 ft.
Obtain { Slab Thickness = 6½ in.
Area of Steel = 0.59 sq. in.

The flange thickness (t) of a T-beam, in this case the slab thickness, is usually assumed as being about $(\frac{1}{3}d)$. Thus the effective depth (d) would become $(3 \times 6.5) = 19.5$ in. In this problem (d) has been taken as 18 in. The width of the stem is governed by the shear, to be shown later, but assumed as 8 in. in this case. Two conditions regulate the amount of allowable overhang of the flange. In this case, since the condition of ($6t$) gives a

CHART K

Area of Steel T-Beams

$f_s = 18{,}000$ lbs. per sq. in.



larger flange width than the condition $b = 1/10$ span, the latter will govern.

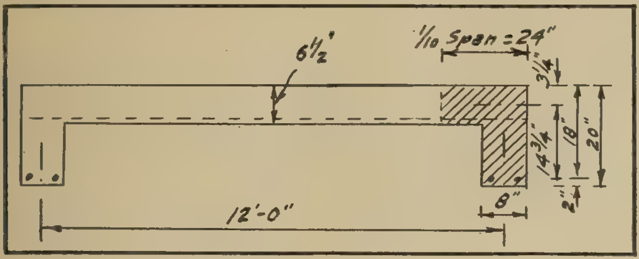


Figure 2

Dead-load of slab:

$$\frac{6.5 \times 12}{144} \times 150 = 81.3 \text{ lbs. per sq. ft.}$$

On each beam, $81.3 \times 6 = 488$ lbs. per ft.
Dead-load assumed stem $= 112$ lbs. per ft.
Live-load, 150×6 $= 900$ lbs. per ft.

Total load on beam $= 1500$ lbs. per ft.

The bending moment would then be

$$M = \frac{w\,l^2}{8} = \frac{1500 \times 20^2 \times 12}{8} = 900{,}000 \text{ in. lbs.}$$

By Chart B, $M = 900{,}000$ in. lbs.

Chart K, isopleth (1), then gives the following information:

Given $\begin{cases} d - t/2 = 18 - 6.5/2 = 14.75 \text{ in.} \\ M = 900{,}000 \text{ in. lbs.} \end{cases}$

Obtain:
$A_s = 3.35$ sq. in.
Use three 1-in. square bars
Actual $A_s = 3.00$ sq. in. (See later reasons given for reduction)

Analytical Solution

The Joint Committee specifies the following formulas for computing the flexural stresses in T-beams:

Neutral Axis in the Flange

Use formulas for rectangular beams and slabs.

Neutral Axis Below the Flange

(Flange large in comparison to stem.)

Position of neutral axis:

$$kd = \frac{2ndA_s + bt^2}{2nA_s + 2bt}$$

Position of resultant compression:

$$z = \left[\frac{3kd - 2t}{2kd - t}\right]\frac{t}{3}$$

Arm of resisting couple:

$$jd = d - z$$

Compressive unit stress in extreme fiber of concrete:

$$f_c = \frac{Mkd}{bt(kd - t/2)\,jd} = \frac{f_s}{n}\left[\frac{k}{1-k}\right]$$

Tensile unit stress in longitudinal reinforcement:

$$f_s = \frac{M}{A_s jd}$$

Neutral Axis Below the Flange

(Flange small in comparison to stem.)

Position of neutral axis:

$$kd = \sqrt{\frac{2ndA_s + (b - b')t^2}{b'} + \left[\frac{nA_s + (b - b')t}{b'}\right]^2} - \frac{nA_s + (b - b')t}{b'}$$

Position of resultant compression:

$$z = \frac{(kdt^2 - 2/3\,t^3)\,b + [(kd - t)^2(t + 1/3)(kd - t)]\,b'}{t(2kd - t)\,b + (kd - t)^2\,b'}$$

Arm of resisting couple:

$$jd = d - z$$

Compression unit stress in extreme fiber of concrete:

$$f_c = \frac{2Mkd}{[(2kd - t)\,bt + (kd - t)^2 b']\,jd}$$

Tensile unit stress in longitudinal reinforcement:

$$f_s = \frac{M}{A_s jd}$$

There are, as indicated by the flexural formulas, two cases theoretically to be considered:

Case 1: The neutral axis in the stem as illustrated by Fig. 3-K.

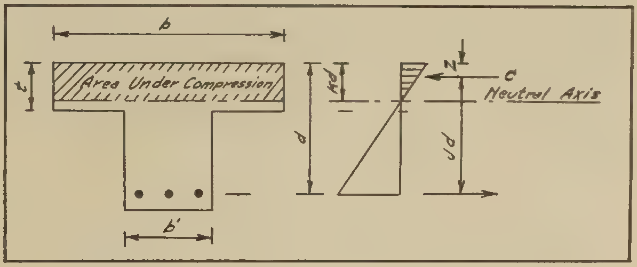


Figure 3

Case 2: The neutral axis below the flange, as illustrated by Fig. 4-K.

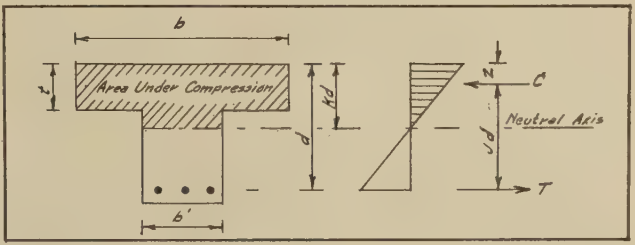


Figure 4

In solving Case 1, a T-beam is considered the same as a rectangular beam with some of the concrete below the neutral axis cut away for economy. If, in the given example, the neutral axis did fall in the flange, the value of (k) would be known for the allowable stresses and we would have

$$kd = 0.4 \times 18 = 7.2 \text{ in.}$$

Since this is more than the flange thickness ($t = 6.5$ in.), it becomes evident that the neutral axis is in the stem below the flange.

The Joint Committee makes one more division, subdividing Case 2 into two classifications:

Case 2a: Neutral axis in stem, when the flange is large in comparison to the stem. In this case the compression in the stem has been neglected, which results in an approximation.

Case 2b: Neutral axis in stem, when the flange is small in comparison to the stem. As the flange becomes smaller in comparison to the stem, the approximation made in Case 2a, of neglecting the compression in the stem, becomes less accurate.

One special case might be considered, when the neutral axis is at the bottom of the flange. In this case, the following formulas would hold true:

$$kd = t$$
$$z = t/3$$
$$jd = d - z = d - t/3$$

The questionable accuracy of field methods of placing reinforced concrete makes somewhat doubtful the necessity of using such complicated formulas for T-beam design. Approximations, if on the safe side, frequently result in economies. Such an approximation will next be considered.

Lowering the neutral axis in a T-beam has the effect, although slight, of lowering the center of compression and thereby increasing the value of (z). Actually, the center of compression is always above the center of the flange. So many engineers make the assumption that the center of compression is at the center of the flange. This assumption, while not always economical, is conservative. Thus the arm (jd) of the force couple is assumed less than it actually is, thereby increasing the total compression (C) and the total tension (T) to values in excess of their actual amounts. This practice will result in a beam somewhat in excess of that required if the full value of working stresses is used. Considering the time of design when using the specified flexural formulas, and the questionable field accuracy, this approximation is quite logical. This approximation will be applied in this issue as well as the next, and comparisons made with the more exact analysis.

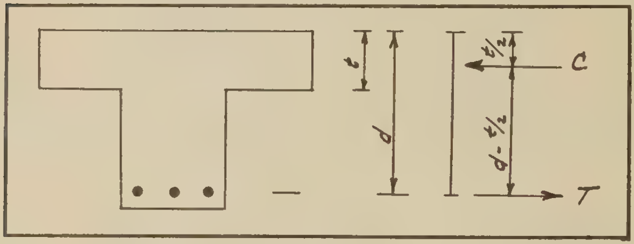


Figure 5

In the flexural formulas, it will be noted that the location of the neutral axis is dependent upon the area of steel used. In assuming a steel area for even the more exact methods of solution, the approximation herein considered is usually made. Since the total tension (T) is found from the expression

$$T = A_s f_s$$

and the arm of the couple (Fig. 5-K) is $(d - t/2)$, we can write the expression

$$A_s = \frac{M}{f_s\,(d - t/2)} = \frac{M}{18{,}000(d - t/2)} \qquad \text{Eq. 1-K}$$

Chart K has been designed to solve this equation. Knowing that the arm of the resisting couple $(d - t/2)$ is less than the actual arm, my usual custom is to reduce the steel area by a slight amount if by so doing advantage can be made of some convenient combination of bars. Thus is the example worked, Chart K gave an area of steel of $(A_s = 3.35$ sq. in.). Knowing that this was already in excess, due to the approximate arm, three 1-in. square bars with an area of 3.00 sq. in. were used. Otherwise the area would have to be increased by using three 1⅛-in. square bars to a value of 3.79 sq. in.

It has been shown that in the example the neutral axis falls below the flange. So the equations for this case must be used. The flange is large in comparison to the stem, so the first group of flexural formulas will be used. This is in itself an approximation for in this group of equations, the compression in the stem has been neglected as being an insignificant portion of the total compression. Substituting in these equations we have

$$kd = \frac{2ndA_s + bt^2}{2nA_s + 2bt} = \frac{(2 \times 15 \times 18 \times 3) + (24 \times 6.5^2)}{(2 \times 15 \times 3) + (2 \times 24 \times 6.5)}$$

$$kd = 6.55 \text{ in.}$$

$$z = \left[\frac{3kd - 2t}{2kd - t}\right]\frac{t}{3} = \left[\frac{3 \times 6.55 - 2 \times 6.5}{2 \times 6.55 - 6.5}\right]\frac{6.5}{3} = 1.2 \text{ in.}$$

$$jd = d - z = 18 - 1.2 = 16.8 \text{ in.}$$

$$f_s = \frac{M}{A_s\,jd} = \frac{900{,}000}{3 \times 16.8} = 17{,}850 \text{ lbs. per sq. in.}$$

It will now be seen that a reduction of the steel area was justified as the steel stress is still under the allowable. If the three 1⅛-in. square bars had been used, the steel stress would have been quite low. Naturally any reduction of steel area from that obtained from Chart K must be made with discretion.

The equation to be solved

$$A_s = \frac{M}{18{,}000(d - t/2)} \qquad \text{Eq. 1-K}$$

can be transposed into the form

$$M = 18{,}000\,A_s\,(d - t/2)$$

which corresponds to the general expression (Eq. 7) requiring logarithmic co-ordinates for nomograph construction.

$$C = L^{mn/r} \,.\, R^{m(1-n)} \qquad \text{Eq. 7}$$

Assuming the same size co-ordinates for (L) and (R), will give a value of $(r = 1)$. Equating the general exponents of Eq. 7 to the actual exponents of Eq. 1-K (transformed) and substituting the value $(r = 1)$, we have

$$\left.\begin{aligned} \frac{mn}{r} = \frac{mn}{1} &= 1 \\ m(1 - n) &= 1 \end{aligned}\right\}$$

Solving these two expressions simultaneously for values of (n) and (m), we will then have

$$\left.\begin{aligned} n &= \tfrac{1}{2} \\ m &= 2 \end{aligned}\right\}$$

Thus the central scale, containing values of (M), must be located half way between the two outside scales and have co-ordinates one-half the size of those used on the outside scales. Fig. 6-K gives the complete details by which the original of Chart K was constructed.

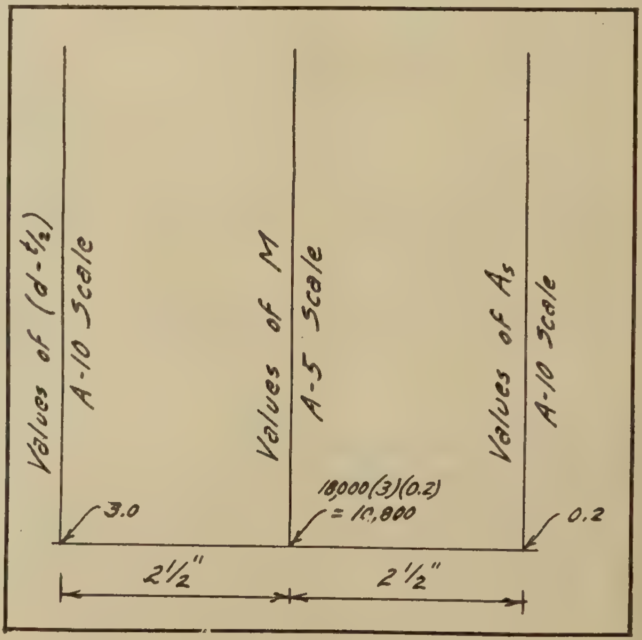


Figure 6

Painless Bookkeeping For Products Plants

The Sixth Article of a Series on a Simplified Method of Keeping Products Plant Records

By F. W. SCHNOEBELEN

Part VI—Cash Book and Sales Register

Having opened the books of the new, hypothetical Standard Block Corporation, as described in the January issue, we are now ready to proceed with the actual recording of the transactions that take place.

The first record form studied was the Accounts Payable and Disbursement Record which was illustrated and described in the February issue. In order to gain a thorough understanding of these forms and the method of recording transactions on them, it may be necessary for the reader to refer back to the December installment in which the bookkeeping principles involved are explained in detail.

In this article we deal with the Detailed Cash Book and the Sales Register.

CASH is money or any commercial paper that the banks will accept at its face value as money. It includes personal checks, bank drafts, cashier checks, post-office and express money orders and travelers' checks.

A cash transaction is made when cash is exchanged for property, i. e., cash is received for merchandise or other property sold, or it is paid for merchandise or other property purchased. When cash is received, it is usually referred to as a "cash sale"; when paid, a "cash purchase."

Exhibit F is an example of a page in the Cash Receipts and Cash Disbursement Record of the model set. This form is used to record any transaction involving cash, whether it is receipts or payments, and to distribute the transactions to their accounts. With this form we do not only keep tab on our cash, but on our bank account as well. This form provides an efficient record of cash transactions that requires only a minimum amount of time. Like the Accounts Payable and Disbursement Record described in the previous article, no special printed form is necessary; any columnar book may be headed as shown and will serve the purpose.

Form Headings

Before we study the entries on Exhibit F we will go over the headings of the columns in order to familiarize ourselves with the form. On the extreme left hand of the sheet we have three columns—the first for discounts allowed on merchandise sold, the second for cash receipts and the third for cash payments. The balance of the cash columns shows the amount of the cash on hand, i. e., the difference between the debit or receipt column and the credit or payment column. Under the main heading "description," we record all the data pertaining to cash received and disbursed, such as the date, account and any other explanation deemed necessary. The columns under the heading "bank," provide a record of the all-cash transactions with the bank. The "debit" column represents the deposits made in the bank and the "credit" column the checks written on the bank. The balance of this column represents our bank balance. By keeping our banking account by this method we eliminate the necessity for keeping the bank balance on the check stubs and place the bank account before us so that the balance may be seen at a glance. We should number all our checks, placing the number in its proper column, so that our checks may be more easily identified. In the "discount earned" column, which is a credit to the business, we place the amounts that were earned by discounts on the purchase of materials. This discount is given for paying the bills within a prescribed time.

The next three columns are debit columns. "Miscellaneous expense" covers all the petty expenses that are paid by cash, on which no charge account is kept. Any bill that we pay, that is, the cash plus the discount that we take is entered in the "accounts payable" column, provided we credited the items against Accounts Payable in the Accounts Payable and Disbursement Record. In the "general ledger" column, we place those items that we can not classify in any other column in the Cash Receipt and Cash Disbursement Record. The last three columns are credit columns. In the "general ledger" column we place all the credit items, that affect any general ledger account. The "account receivable" column comprises the total amount of cash received plus the discount allowed from the sale of merchandise. The "cash sales" column represents the amounts received from cash customers from the sale of merchandise.

How the Form is Used

We will now study the entries on Exhibit F in order to illustrate the method of procedure. Line 2 represents the amount received from customers for payment of merchandise. This, of course, in actual practice would be composed of many amounts from various customers. However, as mentioned previously, we are showing our entries by character, rather than by individual transactions. We debit cash and credit accounts receivable for the amounts. We post the total of the accounts receivable column at the end of the month to the credit side of the general ledger account. The amount of each individual receipt of cash from a customer plus the discount allowed is credited to his account in the accounts receivable ledger.

Line 3 represents the amount of cash received from cash sales, by which amounts we debit cash and credit the cash sale column. The only posting necessary in this case is at the end of the month, when we credit the total amount shown in the cash sale column to the sales account in the general ledger.

Line 4 is an example of how we would handle a note, if we discounted it. We would debit cash for the face of the note and credit the Notes Receivable account in the general ledger. This, then, would balance the notes receivable account in the general ledger.

Lines 5 and 6 represent the sale of an investment and equipment, in which we debit the cash column and credit their respective accounts in the general ledger. The sale of the investment was the cement tile stock that the company held at the beginning of the business. It was sold for the par value, therefore there was no loss or profit on the stock. This wipes out the account in the general ledger. In the case of equipment, it was the sale of an old machine, which reduces our equipment account in the general ledger. If we have not written off all of the depreciation prior to the sale, the balance then is written off and credited to the reserve for equipment.

In line 8 we wish to make a deposit of part of the cash that we have on hand. We credit the cash account and debit the bank account respectively. This then decreases the amount of cash that we have on hand and increases the bank account. Sometimes it is necessary to make cash payment for small items as in line 9. We credit the cash account for the amount and debit the miscellaneous expense column. At the end of the month we post the total of this column to the debit side of the general ledger account or we may post each transaction to one of the major expense accounts, i. e., either manufacturing, delivery, selling or administrative and financial, according to the nature of the expense.

Lines 11, 12, 13, 14, 15 and 16 represent the amounts that we have paid to our creditors. The amount of the check is placed in the credit column of the bank account, which then reduces the amount that we have in the bank. If we are entitled to any discount, we place the amount in the discount earned column. At the end of the month we post the total amount in this column to the credit side of the general ledger. It may be considered either as an additional income or as a reduction in the cost of the materials. The writer prefers the latter method. The sum of the check plus the discount is placed in the accounts payable column. Each individual transaction is then debited to each creditor's account in the Accounts Payable Ledger, balancing the account. The total of the accounts payable column in the Cash Book is debited to the Accounts Payable account in the general ledger, for the accounts payable account, as mentioned previously, is a control account. Payment for raw materials, expenses, equipment and notes payable, as illustrated need no further explanation. The pay roll checks are listed separately in actual practice, with the payee's name written in the explanation column. The sum is debited to accrued pay roll. The accrued salaries are handled in the same way.

As mentioned previously, at the end of the month we foot the columns and post to the general ledger the totals of the discount allowed, discount earned, miscellaneous expense, accounts payable, accounts receivable and cash sales to their respective accounts. In the case of the cash and bank columns, it will save time if only the balances are posted to the general ledger. A simple means of checking the entries in the Cash Receipts and Cash Disbursement Record is to see that the total debits must equal the total credits.

EXHIBIT F.

The Standard Block Corporation of America

CASH RECEIPTS AND CASH DISBURSEMENT RECORD

	Dr.	Dr. CASH	Cr.	DESCRIPTION				Cr.	BANK	Dr.	Cr.	DEBITS				CREDITS			
	Discount Allowed	Receipts	Paym'ts	Date	Account	Explanation	✓	Deposits	Check No.	Checks	Discount Earned	Misc. Expenses	Accts. Payable	General Ledger	✓	General Ledger	Accts. Receiv.	Cash Sales	
1						Brought Forward		1000.00								1000.00			1
2	100.00	7535.00			Customers	On open accts.											7635.00		2
3		30.00			Cash Sales	Buyer's name												30.00	3
4		2000.00			Notes Receivable	Note disct.										2000.00			4
5		3000.00			Investment Sales	Cement tile stk.										3000.00			5
6		100.00			Equipment Sales	Block machines										100.00			6
7																			7
8			12650.00		Bank Account	Name of Bank		12650.00											8
9			5.00		Expense Misc.	Cash purchases						5.00							9
10																			10
11					Creditors	Payment of raw mat.				2300.00	125.00		2425.00						11
12					Creditors	Paymnt of Expense				1500.00			1500.00						12
13					Creditors	Payment of equip.				800.00			800.00						13
14					Notes Payable	To bank				5000.00				5000.00					14
15					Accrued Pay Roll	Pay roll checks				900.00			900.00						15
16					Accrued Salaries	Salary checks				350.00			350.00						16
17																			17
18																			18
35																			35
36		12665.00	12655.00			Totals		13650.00		10850.00	125.00	5.00	5975.00	5000.00		6100.00	7635.00	30.00	36

SCHEDULE G.

The Standard Block Corporation of America

DISBURSEMENTS OF SALES AND RETURNS RECORD

	DESCRIPTION					Accounts Receivable		Debits RETURNED SALES & ALLOWANCES					Credits SALES				
Line No.	Date	No. Invoice	Customer	Address	V	Debits	Credits	Concrete Block	Trim Stone	Concrete Pipe	Misc. Mtls.	V	Concrete Block	Trim Stone	Concrete Pipe	Misc. Mtls.	Line No.
1																	1
2	1/30	500	H. W. Carter	717 Jackson Dr.	V	200.00							200.00				2
3	1/30	1000	Frank Smith	7890 Illinois St.	V		20.00	20.00									3
4	1/30	501	B. E. House	78th & Spring Dr.	V	125.00							125.00				4
41																	41
42																	42
43																	43
44																	44
45																	45
46																	46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56				Totals	V	6250.00	50.00	50.00				V	6250.00				56

In the Cash Book, we showed how the cash sales were handled, but in the concrete products business the bulk of our sales are credit and it is necessary to have adequate records for these.

Exhibit G

Exhibit G is an example of the Disbursement of the Sales and Return Record. As in the case of the previous books of original entry that we have discussed, we will go briefly over the ruling and the heading of the columns. Under the main heading "description," we have the date of entry of the invoice, the number of the invoice, the customer's name and address of delivery. As stated in an earlier article, all invoices should be numbered for reference. It is also necessary to write the customer's name and the location of the job, for it is from this record that the amount of each customer's purchase is posted to the Accounts Receivable Ledger.

Under the heading "accounts receivable," we have two columns—"debits" show the amounts realized from the sales, and "credits" the amount of the products returned.

Under "returned sales and allowances" we place the amount of the returns of each individual in the kind of the product returned column. That is, if trim stone is returned, we place that amount in the trim stone column. In the concrete products business there are usually some returns on each job. Material is left over, or it sometimes happens that the plans are changed after the material is delivered which necessitates the return of the material to the yard and credit must be given to the customer. The total of each column is posted at the end of the month to the debit side of its general ledger account.

The following four columns, headed "sales," are the same as the "return sales and allowance" columns. They represent the amount of the sales of each particular item sold. The totals of these columns are posted to the respective sales accounts in the general ledger.

Illustration of Use of the Form

In line 2 we have an illustration of a sale. We debit the accounts receivable account for the amount of the job and credit concrete block sales. We then post this amount from the accounts receivable column to the accounts receivable ledger, that is, we debit the customer's account in that ledger.

Line 3 indicates the return of some concrete blocks. We credit accounts receivable for the amount and debit the concrete block column in returned sales and allowances. In like manner, we then post the amount from the credit side of the accounts receivable column to the credit side of the customer's account in the general ledger. Any columnar book can be ruled and headed to serve this purpose, which can be purchased in any book store.

This issue concludes our study of the books of original entry. As mentioned previously, to get the most of these articles all schedules must be studied very carefully in conjunction with the articles. However the writer has tried to take those transactions that would occur most often in the concrete products business and explain them in the simplest language possible. If there are criticisms they are welcome. In our next article we will close the books and deal with the closing transactions and statements.

Coming Convention

Concrete Reinforcing Steel Institute—April 15th to 17th. Fifth annual meeting, at the Kenilworth Inn, Asheville, North Carolina.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Cast Stone Institute; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Products Association; F. O. Matthiessen, Secretary, 644 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Fifth annual meeting, Kenilworth Inn, Asheville, N. C., April 15th to 17th.

Iowa Concrete Products Association; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Builders' Exchanges; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

The National Lime Association, Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 3115 Plankinton Arcade, Milwaukee, Wisconsin.

25 YEARS AGO

LAST month CONCRETE was twenty-five years old.

That's not a long time in some industries, but in ours, it's a pretty large slice of the whole of it. You'll remember that it was only a short time ago that the Portland Cement Association celebrated its twenty-fifth anniversary and it was only last month that the twenty-fifth annual meeting of the American Concrete Institute was held.

So, when we go back twenty-five years ago, we are pretty nearly starting from scratch—at least so far as the *organized* progress of the industry is concerned. Of course, there was a lot doing among concretors even then, for the industry had reached a point where it warranted a publication of its own.

From that time on the progress of the industry was recorded in its own magazine. Bound volumes of these early issues of CONCRETE are at hand. In them we can see the forward march of events—the steady growth that has, in twenty-five years, resulted in the present mammoth industry.

What did concretors think about twenty-five years ago? What were their problems then? What did they hope to accomplish?

We believe that answers to these questions will interest every concretor—young or old. To those who have been in the industry during all that period, the answers will serve as pleasant reminders. To those who came in later, they will present interesting historical data.

Accordingly, each month in this column, we will look back into the pages of the corresponding month's issue twenty-five years ago and see how the industry progressed as we page through those earlier issues.

* * *

AN article describing the construction of a solid concrete masonry railroad bridge over the Big Muddy River in southern Illinois by the Illinois Central Railroad.

Cement made by the German-American Portland Cement Co. of La Salle, Ill., known as the "Owl" brand, was used. The foundation concrete was proportioned 1:3:6; the heavy masses of concrete carrying only compression were 1:4:8; and the arch crowns and rings "and, in general where any tensile strain was to be provided for" was 1:2:5 concrete.

* * *

A MEETING of the Society of Western Engineers, held at Chicago on April 6, 1904, was given up entirely to the subject of reinforced concrete, and is reported in this issue. During this meeting a paper was presented by Prof. W. K. Hatt of Purdue University on the subject, "Flexure of Reinforced Concrete Beams."

* * *

IT is particularly interesting to notice, in the light of subsequent knowledge of the effect of water content on strength, that at a meeting of the Railway Engineering and Maintenance of Way Association the following clause was proposed as part of the concrete masonry specification:—

"The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, and the water should rise freely to the surface."

Contrast this with the present modern strength specification now used by railway engineers.

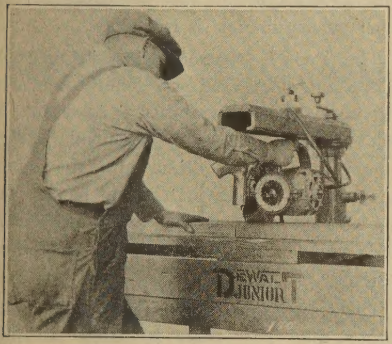
New Equipment and Materials

Dewalt Junior Woodworker

The DeWalt Products Corporation, Leola, Pa., of the DeWalt "Wonder-Worker," announce the addition of a new model, the DeWalt Junior, to their line of all-purpose electric woodworkers.

The DeWalt Junior incorporates the features of the "Wonder-Worker" with balanced, guided power applied to the saw in all cutting positions, instant change from cross cutting to ripping with out stopping the motor, provided with accurate ripping gauge and dials for adjustment to any position. The motor operates from any cycle in either A. C. or D. C. by plugging in the nearest light socket, the manufacturer states.

It is also stated that with 12-in. combination cross-cut and rip saw, which is standard equipment, the DeWalt Junior rips 2-in. stock at the rate of 20 lineal feet per minute.



Fitted on a wooden table 29 x 59, machine complete weighs 235 lbs. It is compact and readily portable and can easily be carried by two men to be set up on a pair of horses or moved about on a moveable truck.

Another feature of the DeWalt Junior is the roller bearing arm, making for easiness in operation.

Chain Belt Now Making Centrifugal Pump

The Chain Belt Company has announced the additional of a centrifugal pump to its line of Rex contractors' equipment. This pump is made in three sizes with capacities of 325, 650, and 800 gallons per minute respectively on a total head of twenty feet.

The features of these pumps are an open type impeller, which allows the handling of dirty water; an automatically lubricated center bearing; the same size suction and discharge flanges, allowing the use of the same size hose for both; and a unit construction which provides absolute alignment and rigidity, it is stated.

The Rex line includes in addition single and double diaphragm pumps, single and double plunger force pumps, and a road pump.

Pipe Pushing Jack Is Modern Device

The Simplex pipe pushing jack, a new tool now in active production, is a modern development said to be finding a ready market. It is a product of Templeton, Kenly & Co., Ltd., Chicago.

Pushing water or gas pipe, or pipe for electrical service or for oil heating supply, under paved streets or alleys, or under gardens or lawns is possible, irrespective of temperature conditions.

The pipe is gripped by jaws in the center of the jack illustrated, and one or two men operating each of the two levers cause the pipe to be pushed through the ground powerfully and accurately, it is claimed.

These Simplex Jacks are built in two sizes—the No. 332 for pushing pipe of ¾ to 2 in. in diameter—and the No. 334 for pushing pipe of 2 to 4 in. in diameter—a feature being that each size of pipe requires a set of jaws to conform to the size of pipe, and by which the crushing or distortion of the pipe is avoided.

The average time required to push a 3-in. pipe through 25 in. of solid soil is between 5 and 6 minutes, using two men on each of the 2 levers—or approximately 23 man minutes, which time also includes resetting the pushing or traveling portion of the jack.

New Koehring Paver Sets Pace with Automatic Operations

The Koehring Company, Milwaukee, Wisconsin, has now made available details on its new 27-E paver which was brought out in January and shown for the first time at the recent Cleveland road show. An illustration and brief description of the paver appeared in these columns in February.

According to the manufacturer, the outstanding features are these:

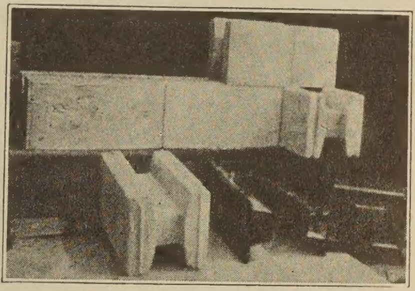
Automatic operation on the new Koehring has brought a complete mixing cycle, including charging and discharging, down to 69 seconds with a one-minute period allowed for mixing. The operator has only to lower the skip and operate the bucket control lever.

Ball and roller bearings are found throughout the power transmission line, as well as in idler sheaves and drum and bucket rollers, to reduce friction to a minimum. All gear units are enclosed and operated in oil.

The principles of the Koehring power steering mechanism are retained.

Grooved and Beaded Block Simple to Lay Up

Five years of experimentation with a block machine that would produce the unit desired by the inventor have resulted in the production of a standard 8 by 8 by 16-inch concrete block with horizontal and perpendicular air spaces, in addition to a bead and groove interlock device at the top, bottom and ends. The unit is known as the Interlock block, and is the product of the Interlock Company, Johnstown, Pa.



Laying up a plumb wall is apparently simple. The manufacturer states that a cement and water solution is brushed along the bead and the grooves of the next course of tile fitted over the bear.

Tower Handles Concrete and Material at Same Time

The handling of concrete and material at the same time is the purpose of a new type of tower on which the bucket travels on the outside of the tower on a set of separate guides and is entirely independent of the material cage.

The contents of the bucket, according to the manufacturer, may be dumped at any point from top to bottom. The bucket attachment, including guides, may be installed on wood towers or other points where hoisting with an outside bucket is applicable.

The Lakewood Engineering Company, Cleveland, Ohio, produces the tower.

New Equipment and Materials

Steel Armoring Material Provides Floor Protection

Wear resulting from rapidly increasing traffic in plants, the carrying of heavy loads on small-wheel trucks, the dropping of boxes, castings, and other heavy pieces, often exacts an unavoidable toll from the best constructed concrete floor.

There is now on the market a material for steel-armoring such floors so that the surface will be as strong as any part of the floor. The material is Floorgard. It is a built-up continuous steel mat that is laid down to form the surface of the floor. The pattern is scientifically designed to present such a surface to traffic that stresses will be taken care of by the steel itself, distributing loads throughout a wide area of floor. Furthermore, the design is such that that portion of the concrete appearing between the steel bars is in no way divided up into separate portions, but is "monolithic" with the rest of the concrete forming the floor body, the manufacturer states.

Under the name Pavegard, a similar steel armoring is used in connection with the strengthening of the surface of roads, streets, alleys, courtyards, bridges, bridge approaches, and other forms of pavement ordinarily subjected to extremely heavy wear.

Both products are manufactured by the Blaw-Knox Company, Pittsburgh, Pa.

Weigh Lorry Compensates for Sand Bulking

To overcome the problem of measuring by volume and compensating for the bulking effect of sand due to its water content, the engineering department of the Consolidated Concrete Machinery Corporation, Adrian, Mich., has designed a portable weigh lorry.

One of the purposes of its design was to make it possible for the average operator to secure optimum accuracy in measuring materials, and this, according to the manufacturer, has been attained.

The frame of the lorry is constructed of channels and angles and the hopper proper is of No. 10 gauge, Keystone copper steel with welded seams. A duplex valve is made a part of this hopper, which operates through a hand lever. The complete lorry is mounted on two trucks, each consisting of two 9-in. diameter, single-flange, chilled-rim wheels, mounted on $1\frac{15}{16}$ in. over-all shaft.

The scale as used is a combination beam scale and dial scale, making it possible to weigh two or three aggregates on the dial scale without a shifting of the beam scale. The purpose of the beam scale is to set the tare weight of the hopper. This type of scale is said to be more rugged than the dial scale.

Cylindrical Tank Transports Mixed Concrete

A new type of ready-mixed concrete delivery tank, known as the R. M. C., is a product of and being placed on the market by the Portland Concrete Machines Company, 53 West Jackson Boulevard, Chicago, of which C. B. Dutton is president.

The tank is furnished mounted on an I-beam so that it may be fastened to any standard make of truck chassis. It may be mounted on any model truck hoist, either high or low lift, and is available in 2 and 3 cu. yd. capacities.

This tank is cylindrical in shape and is loaded through a door located in the top and discharged through a gate at the rear. Its interior is free from shafts or other obstructions, eight vanes being attached to the shell to direct the concrete to the front end while it is to be rotated in transit.

The tank has an independent power unit, consisting of an 8 h.p. Leroi engine which rotates the tank at from 5 to 8 r.p.m. Rotation continues until the tank is ready to discharge, when the front end is lifted and the material flows from the gates at the rear end, through a chute, into delivery hopper or receptacle.

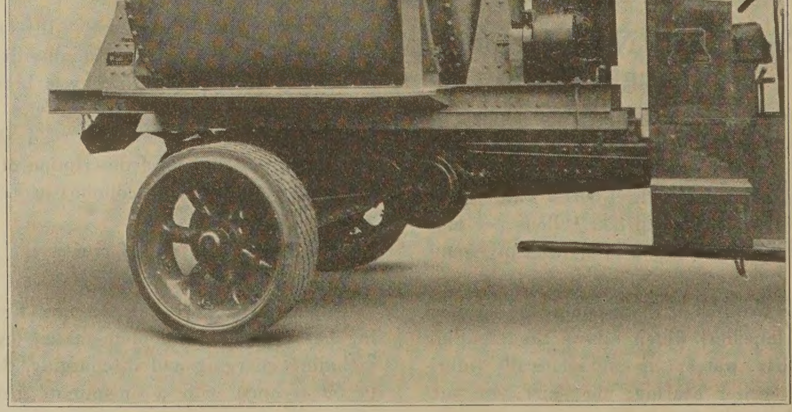
The concrete is hermetically sealed in the tank during transit, to avoid evaporation and segregation. Delivery of concrete on the job of any desired consistency, without loss of strength, or aeration of the mix, is guaranteed, the manufacturer states.

Two-Piece AggreMeter Plant Is Portable

The Erie Steel Construction Company has designed a new bin, which will be known as the Type G-Portable. This new bin was designed especially for platform-operated AggreMeters. The bin bottom is off-center, which allows more floor area and shelter for the operator. It is also impossible for the aggregates to arch in a bin of this type because the sides are almost perpendicular, it is stated.

The Type G AggreMeter plant is especially suited for road and general contracting work where portability is essential. It can also be adapted to central mixing plants for loading direct into the mixer hopper. On account of the bin bottom being off-center the mixer can be set under or in front of the bin depending upon conditions.

The capacities of this type are much larger than any other so-called portable bin, the manufacturer states. It is built in 60, 73, 74 and 91 ton capacities.



RAIL STEEL REAL STRENGTH

twenty tons for endurance

IN each square inch of rail steel 20 tons of its elastic strength exceed load requirements and guarantee real endurance. . . . . .

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MEMBERS
BUFFALO STEEL COMPANY, TONAWANDA, N. Y.; BURLINGTON STEEL COMPANY, HAMILTON, CANADA; CALUMET STEEL COMPANY, CHICAGO, ILL.; CANADIAN TUBE AND STEEL PRODUCTS LIMITED, MONTREAL, CANADA; CONNORS STEEL COMPANY, BIRMINGHAM, ALA.; DANVILLE STRUCTURAL STEEL COMPANY, DANVILLE, PA.; FRANKLIN STEEL WORKS, FRANKLIN, PA.; LACLEDE STEEL COMPANY, ST. LOUIS, MO.; MISSOURI ROLLING MILL CORPORATION, ST. LOUIS, MO.; POLLAK STEEL COMPANY, CINCINNATI, OHIO AND WEST VIRGINIA RAIL COMPANY, HUNTINGTON, W. VA.

RAIL STEEL
for concrete reinforcing

About Makers of Equipment and Materials

Change of Management in Multiplex Company

A change of management in a pioneer concrete machinery manufacturing company occurred recently when *Frank Muenzer* assumed charge of the *Multiplex Concrete Machinery Company*, Elmore, Ohio. He has been connected with the firm for twenty-three years. *A. Feilbach*, who has been president and manager of the business for twenty-five years, has resigned.

To Mr. Muenzer is unofficially given the credit for the innovating of the stripper. He is said to have designed the one-piece mold box and the method of stripping block from the mold box so that a troweled surface is presented on the four sides. Following the building of the machine, time and efforts were devoted to its perfection. They have resulted in a machine so built that parts subject to wear are enclosed in the lower portion and run in a bath of oil.

Attention has also been devoted to equipment for the production of other products. Among these are hand machines producing units ranging from chimney block to hollow block and building tile and flue block.

The latter, newly designed, is cored out to reduce its width and provide insulation. The machine is so arranged that a full block can be produced for regulation size flue and half block for gas or fireplace. Block are so arranged that they may be tied by metal bonds or a course of brick may be laid around them and tied into the wall.

American Hoist Export Sales Manager

The American Hoist & Derrick Company, whose works and main offices are at St. Paul, Minnesota, announces the appointment of *F. E. Bauer, Jr.*, as export sales manager with offices at 50 Church Street, New York City. Mr. Bauer has represented the American Hoist & Derrick Company in foreign fields for many years and is acquainted with business conditions in Asia and the Orient.

Blaw-Knox and A. W. French Merge

"*The Blaw-Knox Company*, Pittsburgh, announces the merger of *A. W. French & Company* of Chicago with Blaw-Knox Company and subsidiary companies.

A. W. French & Company are manufacturers of the Ord concrete road finishing machine, Nu-Method finish grader, new ball wagon grader, etc.

The personnel and policies of A. W. French & Company will continue as heretofore and its plant and sales organization will function as a separate division of the Blaw-Knox Company.

American Hoist Branch Office

The American Hoist & Derrick Company, manufacturers of hoisting machinery and crawler type shovel-cranes, have opened a branch office at 139 Townsend Street, San Francisco, California. A large stock of new equipment and parts is carried and facilities have been provided to insure on-the-ground service to all users of "American" hoisting machinery in northern California.

The establishment of this branch office terminated a connection with Harron Rickard & McCone, who handled the "American" line in San Francisco and vicinity for many years. *Boyd Nixon* has been placed in charge of the American Hoist & Derrick Company's San Francisco office.

New Butler-Bin Distributors

The Butler Bin Company, Waukesha, Wisconsin, have appointed the following new distributors:

Arizona Road Machinery Co., Phoenix, Ariz.; *General Equipment Mach. Co.*, Miami, Fla.; *Hofius-Ferris Equipment Co.*; Spokane, Wash.; *J. B. Harbison Equipment Co.*; Little Rock, Ark.; *Loggers and Contractors Equipment Co.*, Portland, Oregon; *Mechanical Supplies Co.*, Cincinnati, Ohio; *W. T. McDonald & Co.*, Indianapolis, Ind.; *New Mexico Road Machinery Co.*, Albuquerque, N. M.; *Stannard-Arnold Co.*, Salt Lake City, Utah; *J. C. Sheehan & Co.*, El Paso, Texas; *Tri-State Equipment Co.*, Memphis, Tenn.; *Taylor Tractor Co.*, Columbus, Ohio; *Geo. V. Treen & Co.*, Charleston, W. Va.; *Wiley Bros., Inc.*, Oklahoma City, Okla.

INDUSTRIAL LITERATURE

Catalog of Building Accessories

Concrete building accessories that are products of the Universal Form Clamp Co., Chicago, are cataloged in a new publication which has just made its appearance and is known as No. 300.

In it are found the profuse actual job installations and uses typical of this publication. It is comprehensive as well, practically all building products used for forms and centering and reinforcing steel being included.

Of more than usual interest is the method of hanging forms for concrete from structural steel members, to which four pages of descriptive matter are devoted.

Two Surfacer Folders

Users of surfacers, both pavement and structural, will be interested in two small folders describing the Berg brand of equipment manufactured by the *Concrete Surfacing Machinery Company*, Cincinnati, Ohio.

The first of these describes the new, improved Model "A" portable, electric surfacer and finisher, built to withstand a cutting strain of 2700 to 3500 r.p.m.

The second folder describes the concrete highway surfacer, a one-man machine for cutting down high spots, surface irregularities, uneven expansion joints, and repaired patches.

Compressor Literature

Ingersoll-Rand Co., 11 Broadway, New York City, announces a new direct-connected, gas-engine-driven compressor. It is designated the Type XG, and is being introduced following several years of development under actual operating conditions. It consists of a 2-cylinder, 4-cycle gas engine, direct-connected to Ingersoll-Rand compressing cylinders with I-R plate-type valves.

Features of the XG are its rugged construction, accessibility of frames and running gear, and economy of floor space and foundation requirements. The compression end can be furnished to accommodate any of the usual conditions of pressure range. The XG is adapted to continuous service in the oil and gas industries, or to general industrial use. It is described in *Bulletin* 3149.

More Curing Capacity

Increased capacity with present curing facilities is possible through the use of an overhead conveying system, according to a four-page folder issued in February by the *Cleveland Electric Tramrail division* of the *Cleveland Crane and Engineering Company*, Wickliffe, Ohio.

The publication consists chiefly of illustrations showing the Cleveland tramrail system in use in the kilns, ovens, and dryers of a number of industries, accompanied by brief text.